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CURTIS E. WHITTLESEY, Secretary and Treasurer.

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THE COLORADO CONVENTION.

The Colorado electric light and railway men held another one of their successful annual conventions last week, and as usual succeeded in rounding up at convention a much larger percentage of the central-station operating men in that territory than any Eastern state association seems able to bring out. Probably the most notable feature of the convention program was the report on the freedom from lightning troubles the past season on a transmission system which has been peculiarly afflicted with this trouble. From a condition where 73 per cent of the numerous lightning storms caused complete or partial shut-downs on a large transmission network, to a condition of almost entire freedom from such shut-downs, is certainly a remarkable record. The aluminum arrester seems to be making good the claims made for it by its friends at the close of last season.

TREE TRIMMING.

The question of tree trimming has so long had the reputation of being a painful subject among electric light and telephone men that it will doubtless be a surprise to some of the old-timers to see how easily and with what little friction this question is handled by some companies. Any town with well-shaded streets, without alleys in which pole lines can be run, is difficult for overhead construction. To the natural physical difficulties there is frequently added the difficulties of getting property owners to allow trees to be trimmed. Much of the old trouble about tree trimming and property owners' consent was due to lack of consideration or diplomacy on the part of the manager and line foreman. In a matter which can arouse so much public sentiment, an ignorant and careless lineman can do considerable damage both to trees and to the public's good opinion of the company. It is well for someone with more diplomacy than the average lineman to be present when trimming is going on. It not infrequently happens that trees are trimmed to the point of severe mutilation even under the direction of a property owner by the lineman for an electric light company, the property owners, in fact, being glad of the opportunity to get their trees trimmed without expense. In view of the small amount of trouble between property owners and electric light companies where the matter is handled diplomatically, there would appear to be little excuse for trouble in any locality if the right men are set at the job. In some cities tree trimming is done under the supervision of some city official, being taken out of the hands of individual property owners. This is likely to insure more consistent, uniform trimming. The plan of limiting trees to a certain height and building pole lines with 40-ft. or 50-ft. poles so as to bring wires above the trees, has also been adopted with success in some towns. People in general recognize that electric wires are a necessity if they are to have modern conveniences in a town, and they are willing to consent to anything reasonable in the way of tree trimming if they are consulted about it instead of having it forced upon them.

The Propagation of Electric Waves in Wireless Telegraphy.

Although wireless telegraphy is in very evident existence, many of its phenomena are only roughly and imperfectly conceived of, owing to the fact that they escape our senses. We cannot see the electromagnetic waves. If we could only secure photographs of them in different stages of their formation and progress, we should be greatly aided in understanding the detailed actions. As matters stand, we have to grope our way slowly toward the truth. The article by Dr. James E. Ives in this number is directed to a consideration of the actions which occur near the sending mast when waves of the natural fundamental frequency are being emitted from it. The article points out that when the mast is initially discharged the electric flux surrounding the mast comes sliding down to earth. The article endeavors to account for the subsequent disengagement of the flux from the mast solely by the electric forces resident in such flux—namely, in the tension along the flux lines and in the distension perpendicular thereto.

In the reasoning presented, so far as it goes, we concur. But we go further. No allusion is made to the magnetic action, and this magnetic action is at least half of the phenomenon. If we consider what happens at the moment of the mast's initial discharge, the electric flux system collapses and comes rushing in to the ground plate at the center, with the speed of light, as suggested in the article. But we cannot have electric flux moving freely in space all alone. It must be accompanied in any single electromagnetic disturbance by magnetic flux perpendicular to itself and across the path of motion. That is, the electric flux, when tumbling, must produce a magnetic whirl around the mast as axis in a sort of system of concentric beehives. The blow to the ether which sets up this magnetic flux is delivered by the collapsing electric flux, and is the whipcrack that sets off the moving disturbance. The electric flux alone tends to vanish at the ground plate; but the magnetic flux created by the motion possesses electromagnetic inertia and expands outward from the mast, with the electric flux-loops straddling it. The pictures of electric flux distribution in Figs. 2 and 3 suggest that the flux never rises above an altitude of 66 deg. above the horizon, as judged by an observer at the base of the mast. Blondel, however, makes them rise to the zenith, or 90 deg. overhead, except that their intensity is vanishingly small at the zenith. It is a matter of little practical consequence whether we suppose the flux extends only to an altitude of 66 deg., and keeps up to that range as it expands, or whether we suppose that it extends up to the zenith, but is so weak near the zenith that it does not begin to be appreciable until 24 deg. below—that is, at an elevation of 66 deg. Nevertheless, from the standpoint of mental conception, there is a difference. In Hack's diagrams the expanding wave system is hollow conical. In Blondel's it is hemispherical, with zenith zero.

The Scientific Mare's Nest.

It is now somewhat over a year since William Ramsay announced in a rather modest and tentative fashion that radium emanations (whatever they may prove to be) broke down salts of copper into the alkali metal. His statement was loudly heralded by the scientific yellow press, and was received almost prayerfully by the apostles of radium omnipotent. Articles on the new alchemy began to go the rounds and there was interesting speculation on the possibility of the synthesis of gold. It seemed almost too bad to dim so bright a prospect, but a recent research by Madame Curie and an assistant seems to consign it to the corner of oblivion reserved for things that are not so. In brief, Madame Curie went about repeating the English experiments and found negative results after eliminating as far as possible the obvious possibility of using impure chemicals. It was found that spectroscopic traces of lithium are very hard to get rid of, the metal being apparently almost as widely distributed as sodium and potassium. The more precautions against contamination the less signs of the supposed transformation, so that the whole affair must be set down to too great haste in drawing conclusions from slender premises. The spectroscope is a marvelously sensitive instrument, and like all sensitive instruments must be used with extreme caution.

This is not the first time that the transmutation of metals has been announced on spectroscopic evidence, and by the same sort of mistake, more than 20 years ago, a really distinguished scientist reported in a sealed communication to the French Academy of Sciences the condensation of zinc into cadmium. In due time the communication was referred to the Committee on Papers, of which the lamented M. Janssen was then chairman. That accomplished physicist and astronomer evidently had his suspicions in the matter, which was politely referred to its distinguished author for further details. It never got back to the Academy, for traces of cadmium were found in the zinc before treatment and the story leaked out only through those subterranean channels that unite the world's body of investigators. The only printed record is a brief note in the *Comptes Rendus* in which the action of the committee is reported. Sir William Ramsay seems to have been less fortunate than his compatriot, and trusted the wizardry of radium far enough to make formal publication, even though cautiously. He is far too brilliant an investigator to have the thing laid up against him, but it certainly should be a warning to the radium contingent to go a little slowly in its vaticinations. The kind of evidence on which they rely is none too convincing and still rests in no small measure on unrepeated experiments. If Madame Curie should get after these in her painstaking way there may have to be quite a grist of recantations. Especially should she produce some metallic radium in appreciable quantity, the hitherto over-credulous may get some very rude shocks. It is about time for the weird mass of experiment to be set in order, and there is no one better able to undertake the task than Madame Curie. Meanwhile, mindful of this recent disclosure, it is wise to be cautious in accepting as facts the farrago of speculations that rest on no tangible chemical basis and derive their chief support from common factors of hypothesis.

Light as Protection.

It used to be a common saying that an arc light is as good as two policemen. That depends on the policemen, of course, but it certainly is a fact that a really well-lighted street is considerably safer than one badly lighted. There seems now to be on one of these periodical waves of violent crime that follow business disturbances, as tidal waves an earthquake.

For adequate protection both more and better policemen and more and better lights are needed. A dimly-lighted thoroughfare favors all sorts of nocturnal prowlers and a really brilliant street repels them. The common and economical plan of evaluating street lighting by the infinitesimal minima between lamps would assuredly receive the official endorsement of the Highwaymen's Union. In the average city few or no streets are adequately lighted, and in the less favored quarters, which experience has shown to be where crime is most rampant, the lighting is generally bad. In the better residence quarters, too, lights are usually far too widely spaced. The result is that on a dark night burglars and thugs can skulk about quite unperceived by the patrolman on his beat. It is time for reform in this matter—time to realize that present conditions are such as to call for extreme precautions.

The ordinary city, to be brutally frank, is parsimonious about its street lighting, far more so than in most other municipal matters. The money paid for street lights goes straight into the coffers of private corporations, gas or electric, while that paid for many other things filters through the hands of various city departments not generally effectively divorced from practical politics. Then, too, in the days when lighting was more extensive than it now is, an effort was made to distribute lamps over many miles of streets while yet bringing the cost within a modest appropriation, and the result has been very wide spacing of the lights, and very meager illumination. The real need is for more lights, more closely spaced and more powerful. Something, too, can be done in the way of better arrangement and better distribution, but most of all, the requirement is for a greater absolute quantity of light. The more recent illuminants show great improvement in output of light for unit cost, so that central stations can do much to help the good cause along. The cities on their part would do well to keep up their end by providing more lights as well. The extra expense would in the long run be a good investment in securing convenience and prosperity. The investment in street lighting ought to increase at a rate similar to that which applies to other important municipal affairs, while in many cases it falls far behind. Street lighting is not a mere luxury; it is a necessity and a measure of public safety. As a rule, the population and valuation of a city increase more rapidly than its street mileage, so that at any fair rate of increase the illumination ought steadily to improve instead of remaining stationary either in amount or in cost. It is high time to inaugurate improvements and to give the citizens their due in convenience and safety.

SIMPLIFYING SOME OF THE CALCULATIONS OF LIGHT.

In our issue of last week, Mr. Carl Hering contributed an article on photometric units in which he pointed out among other things the correspondence between the units of illumination and of source brightness, notwithstanding the fact that the former is ordinarily expressed in terms of foot-candles, while the latter is ordinarily expressed in terms of candles-per-square-inch. In this number Mr. Hering comes again to the charge, and illustrates some of the discrepancies which misconception on this subject may involve. There can be no doubt that, as Mr. Hering says, our existing system of photometric units is irrational and unscientific. From one standpoint, this irrationality is not surprising. To the physicist, light is electromagnetic radiant energy that incidentally stimulates the retina and produces sensation according to complex laws. To the photometrist, light is a physiological sensation that is incidentally dependent upon radiant energy for its production in a complicated manner. Is it any wonder that between physics and physiology the student of scientific photometry has a hard time of it? From this point of view it is a matter for mutual congratulation that we have even a fairly working practical system of photometry. Of course, we hope for improvement, and Mr. Hering's article is valuable as inducing that state of penitence and contrition in our minds which may prepare us for salvation. The article is, moreover, useful in clearing up certain numerical relations between illuminated and reflecting surfaces. The method of determining the reflective coefficient of a flat surface is an interesting corollary. The theory of the subject is, however, not new, although it is far from being generally understood.

The whole subject on its technical side was admirably treated by Prof. A. Blondel in *La Lumière Electrique* for July 7, 1894. Blondel there showed that the candle-power, or luminous intensity, of a source in a given direction, was the ratio of the flux of light in a little solid angle, with that direction axis, to the magnitude of said little solid angle. He also pointed out that some writers expressed the intrinsic brightness of a source as the ratio of the total emitted flux to the surface of the source, while others expressed it as the candle-power to the surface. He indicated that these two expressions are equivalent, if we take a solid angle as a dimensionless numeric.

In order, however, to avoid the confusion that Mr. Hering's article decrys, Blondel proposed to confine the term intrinsic brightness of a source to the ratio of candles to source surface and to use the term "intrinsic radiation" of a source for the ratio of luminous flux to source surface. The former would naturally, and unfortunately, be expressed in this country by candles per square inch, and the latter by candle-lumens per square inch. If a solid angle is regarded as a dimensionless numeric, these two expressions will differ only by a numeric. The subject was also reviewed briefly by Dr. A. Macfarlane in a paper read before the American Institute of Electrical Engineers in January, 1895, although the conflict between intrinsic brightness and intrinsic radiation is not discussed in that paper.

The irrationalities in our present engineering photometric units, as properly criticised by Mr. Hering, are, indeed, numerous. They exist in nomenclature, such as in the term foot-candle, which suggests the product of a distance and an intensity, whereas the ratio of a flux to a surface area is actually connoted. They exist in dimensions, such as in using one unit of dimension to express candles-per-square-inch and another unit to express illumination as foot-candles. They might also be detected in other matters. Perhaps when the physiological relations between light-perception and radiant power production shall have been determined, and made amenable to individual measurement, we may hope that the physicists will lead the remorseless machinery of mathematical physics into the present chaos. There will probably be some crushing of old ideas in effecting the reform; but, as Bismarck is said to have observed, "One cannot make an omelette without breaking eggs."

A. I. E. E. Meeting.

The next meeting of the American Institute of Electrical Engineers will be held on Oct. 9 in the auditorium of the Engineering Societies Building, at 29 West Thirty-ninth Street, New York, at 8 p. m., at which time a paper entitled "High Potential Underground Transmission" will be presented by Messrs. P. Junkersfeld and E. O. Schweitzer.

Kansas Electrical Convention.

The eleventh annual meeting of the Kansas Gas, Water, Electric Light & Street Railway Association will be held at Pittsburg, Kan., Oct. 8 and 9. The following is a list of the papers to be presented at the meeting:

Street Lighting—Arc and Series Tungsten, by Mr. N. R. Birge; Electrical Jobbers, by Mr. P. B. Chaney; The Correct Rate to Be Charged by Central Stations, by Mr. W. A. Scothorn; Commercial Insulation of Wire, by Mr. F. H. Dimick; Finances of the Light Business, by Mr. H. V. Forest; Steam Turbines, by Mr. C. R. Mackay; Incandescent Lamps, by Mr. S. H. Doane; System of Bookkeeping and Records, by Mr. Dow R. Guinn.

Kuzel Tungsten Lamp Patents.

Two patents were issued Sept. 15 to Hans Kuzel, of Vienna, Austria, relating to the tungsten lamp. One is on the employment of a metal carbide for attaching a tungsten filament to the leading-in wires. One or more of the rare earth metals or nickel, cobalt or iron is mixed in a powdered state with carbon and a sufficient quantity of sugar solution or the like to form a pasty mass, a portion of which is applied to the filament connection and gradually brought to a white heat by an electric current or otherwise; the carbon present then combines with the metals used to form a carbide. A solder very suitable for the process may also be obtained by mixing 90 parts of finely powdered vanadium, 5 parts of powdered graphite and 5 parts of gum arabic.

The second patent describes a means of supporting a metallic filament, involving the use of a spider or hooks between the usual upper and lower supports of such a filament.

Anglo-Japanese Water-Power Plant.

Preparations are being vigorously made for the construction of the largest water-power plant so far projected in Japan, in which British capitalists and Japanese financiers are co-operating. The company is to have three generating stations in the province of Shiznoka, about 100 miles west of the city of Tokio, to which the bulk of the power is to be transmitted. The first station, to be completed in the near future, will have 60,000-hp capacity, the total cost of this station being estimated at $8,750,000.

The head at this station is 600 ft. The dam, which is 300 ft. high and 700 ft. long, serves to store the water of Oi River. The machines to be installed in the station are six three-phase, 25-cycle, 6600-volt generators direct-connected to 13,500-hp vertical water wheels; two 500-hp direct-connected exciters, and transformers for stepping-up to 66,000 volts. The length of the transmission line is about 105 miles. Steel towers 50 ft. high with 450-ft. span will be used. The entire line will be in duplicate so as to insure continuous service. At the substation end of the line the voltage will be stepped down to 6600 volts and distributed in Tokio, Yokohama and nearby cities and towns. Contracts have already been made for the sale of about 20,000 kw.

The engineers engaged in the work are: Messrs. William C. Burton, James D. Schuyler, Albert S. Crane, and J. M. Howells, of the United States; Mr. James Walker, of England, and Messrs. K. Morita and K. Kishi, of Japan. The estimated expenditures are $3,773,000 for hydraulic work, $3,889,000 for electrical work, and $1,133,000 for buildings, right-of-way, etc.

Seventh Annual Meeting of Vermont Electrical Association.

The seventh annual convention of the Vermont Electrical Association was held at the Bennington Club, Bennington, on Sept. 16 and 17, and proved an unqualified success, at least 100 members and guests being present. President Larrabee, of Bennington, called the meeting to order, and pointed out in an excellent address that the member companies held "natural monopolies," for the reason that in hardly any town in the State could two rival systems exist. There are in Vermont some 53 central station systems owned by corporations or individuals, in which several million dollars are invested, doing more for the respective communities than they got credit for. With regard to legislation, Mr. Larrabee said: "We do not wish to go on record as opposing any legislation giving the greatest good to the greatest number, but we do want to be recorded as willing and anxious to assist our legislators in the foundation and enactment of laws giving both the public and the investor a reasonable amount of protection. No doubt some action toward the creation of a public service commission will be taken at the coming session of the Legislature, and our committee on public policy is making strenuous efforts preparing to meet the action more than half way by investigation of the working of commissions in other States, collecting a host of information which will be of great value in framing a new public service law.

"An attempt was made to have the last Legislature pass a law regulating the price of gas and electricity by fixing a maximum price regardless of local conditions. To prevent such unjust measures being enacted will be a part of the work of the public policy committee, and, while it will no doubt be perfectly safe to leave the matter entirely in their hands, each member should be ready and willing to put his shoulder to the wheel and help over the hard places in whatever way he may be able."

President Larrabee expressed his belief that there should be a closer relationship with the National Electric Light Association, and urged the appointment of a committee to take the matter in charge.

Mr. H. C. Rice, of Cleveland, then presented a very interesting paper on the development of the tungsten lamp, tracing the article through from the ore to the perfected filament and illuminant. He also discussed incisively the problems of selling and introduction. Mr. H. W. Brown, in the discussion, pointed out the present impossibility of free renewals, and gave data as to the monthly rental plan adopted, as at Lowell, Mass., where a flat rate of 25 cents per month is charged for renewals; or Elkhart, Ind., where 24 cents is charged for a 40-watt lamp, 27 cents for 60-watt and 30 cents for 100-watt. Some samples were shown of the 25-watt tungsten, but it was felt that this and the 250-watt are not in the range of "practical politics," although the 250 is being installed at Hartford, Conn., experimentally for street lighting. Mr. Larrabee pointed to the relief that the new lamp gave to a plant already loaded, avoiding the necessity of larger generators, the investment for which was not freely forthcoming just now. The discussion of this timely and useful paper occupied the whole afternoon.

The evening session at the club was participated in by many leading citizens of the town and State, and the room was crowded to overflowing. Mr. Frank B. Rae, Jr., read a paper on "Commercialism," in which he predicted that while commercial engineering had been neglected in the central station field only five years ago, at the end of the decade, electrical engineering would be only incidental to it. Mr. Rae then defined his topic and took it up under the various heads of public policy, general management, soliciting for new business and advertising. All these items were admirably discussed, many helpful suggestions being offered to managers, particularly in regard to campaigns for patronage. Mr. Rae said that the danger in pushing for new business was the tendency to adopt rather than adapt, each company having some special or unique condition of

difficulty to surmount. No two sets of local conditions are alike, and even interchange of experience did not go the whole way. The company that relied wholly on the brains within its organization was sure to have a hard time getting there. Ideas must be gathered from outside and then utilized in such shape as would best fit each emergency. As to soliciting, Mr. Rae believed in having a general scheme, but one that would be flexible enough to meet the idiosyncrasy or idiocy, if they preferred the word, of the individual customer. In respect to advertising, he also showed how flexible the word is and how comprehensive of all that will influence the public mind favorably. The most successful printed advertising matter for a central station was that which reflected most broadly to the advantage of the city.

Mr. George Williams, of H. L. Doherty & Company, then gave an illustrated talk on advertising, his clever remarks being profusely illustrated with lantern slides of night views taken of signs all over the country, inclusive also of street effects and outline lighting. He urged a liberal policy by central station men in regard to this modern development of the lighting art.

Mr. Glen Marston, of New York, followed with a short talk on "Public Policy," in which he dealt with the tendencies of the time. He said: "No far-sighted public utilities man objects to reasonable State regulation; it is the unreasonable and municipal regulation that harms. Nor do we object to municipal ownership as such, but to the false showings made by municipally owned plants, which make the public believe that such plants operate more cheaply than those owned by individuals or corporations." He held that reasonable control, which should include municipal with private plants, would show that business men can conduct their business better than politicians can conduct similar business for a city, and, if the real facts were known, no city would ever want municipal ownership. In describing the work of public utilities commissions, Mr. Marston pointed out that they were as beneficial to the small company as to the large, and he said without qualification that no public service law honestly drawn for the mutual protection of public and company but would prove of immense benefit to the lighting industry.

Mr. T. C. Martin, of the ELECTRICAL WORLD, then delivered an address on "National and State Electric Light Associations," stating that as an honorary member of the National Electric Light Association he had been asked to attend and express, on behalf of President Eglin, its interest in the welfare of the State organization and its desire for closer co-operation under the Doherty plan. He outlined the growth of the industry in 25 years of existence, and showed how steadily the central station industry continued to loom up in magnitude and importance. He outlined the actions and decisions of public service commissions, such as those in Massachusetts, New York and Wisconsin, and urged that only by working together, nationally and locally, could they exert legitimate pressure on such commissions and on lawmakers, so as to secure the equitable treatment to which they were entitled. Mr. Martin expressed his confidence in such commissions, and said that even if they were regarded by some as an evil, there were worse evils against which they acted as a defensive dam for capital and the security of investment.

At the executive session the question of co-operating with the State Legislature in drafting a fair and equitable public utilities bill was discussed at some length and steps taken toward that end. The matter of closer relationship with the National Electric Light Association was also favorably considered and a conference will be held. The following officers were elected: President, F. H. Parker, Burlington Light & Power Company, Burlington; first vice-president, James E. Davidson, Consolidated Lighting Company, Montpelier; second vice-president, C. E. Parker, Vergennes; secretary-treasurer, A. B. Marsden, Manchester; members of the executive committee, three years, C. C. Wells, Middlebury, and George S. Haley, Rutland.

Mr. Larrabee, retiring president, gave an informal banquet at the club on Wednesday evening to his successor, Mr. Parker. A clambake took place on Thursday in a pine grove outside the town, when a halcyon and vociferous afternoon was spent, baseball occupying part of the time. President Eglin, of the National Electric Light Association, rode over from Lenox, Mass., in an automobile to attend it. During the convention Mr. E. D. Strickland, from Buffalo, held a "rejuvenation" of the Sons of Jove.

The General Electric and Westinghouse companies were well represented at the convention, the latter company distributing watches, on the dial of which the hours were indicated by the letters in its name. These were in great demand. Mr. Harry C. Rice, vice-president of the G.-I. Lamp Company, made an address, referred to above, on tungsten lamps, and was rewarded by the deep interest shown by all the operating members.

Annual Convention of the Edison Association at Lenox, Mass.

The Association of Edison Illuminating Companies held its twenty-fourth annual meeting at Lenox, Mass., Sept. 15, 16 and 17, the meeting being, in fact, the twenty-ninth convention of that body. The far-famed beauty of the Berkshire Hills and the fine weather contributed toward a record attendance, over 200 being present; and nothing marred a perfect week except the mistiness due to the forest fires around about, whose smoke obscured the distant ranges and more lofty peaks, such as Greylock. As a matter of fact, the extreme drought throughout the region directed more than usual attention to the subject of water power plants, and the necessity of large storage capacity if they were to remain in constant operation during periods of minimum flow.

The meetings were held in the ballroom at the Aspinwall Hotel, the convention headquarters, a chamber spacious enough, but not too large for the work. As is well known, the Edison convention always sits with closed doors, but the interest in many topics was so intense that at times even the official stenographer was shut off, so many speakers desiring this privilege in order that they might indulge in heart-to-heart discussion. The first session was held on Tuesday, Sept. 15, at 9:30 a. m., when President Alex. Dow, of Detroit, made an admirable address, referring especially to the late financial storm and its effect on the lighting industry, proving the rule that fixed charges were a large element in expense and cost; that smaller output did not reduce such expenses or others proportionately, and that larger output did not increase them. He intimated that the experience pointed to closer scientific economy and a higher type of engineering, in plant, line, and customer's apparatus. In referring to the vital topic of metallic filament lamps, he suggested that perhaps the closeness of regulation required with the carbon filament would no longer be necessary, and that they could safely essay a wider range of voltage. As to price, the tungsten lamp was now a commercial product, and the member companies could henceforth adopt a definite commercial policy in regard to it. At the same time, he intimated that it was reasonable to hold that the stage in the new art, when a large profit to the lamp maker at the expense of the central station company was justifiable, had passed. Local companies should be put in a position to offer tungsten lamps to their customers on attractive terms.

President Dow was strong in his urgency of industrial power development, and remarked: "In the matter of sales of factory power, can we establish a class of service sufficiently reliable to be commercially acceptable and yet requiring less investment and less line maintenance than is now our standard? Is there not a possibility of distributing by overhead lines, at comparatively high voltages, alternating current power regulated closely as to frequency, but not over closely as to voltage, so that there may be a minimum of copper and of substation investment; this power contracted to be delivered only during ordinary factory hours, so that during evenings and holidays and Sundays these high voltage lines may be shut down to permit of maintenance work and new connections? Our theory has heretofore required 24 hours' continuous service, and a regulation, even

on factory circuits, good enough for our incandescent lighting—a much higher standard of regulation than is to be found in a plant which a factory owner operates for his own use. The factory owner makes his repairs nights and Sundays. Does not continuous 24-hour service for this class of business increase our investment to a point which is not warranted by the commercial conditions?" Incidentally, he hinted at possible reform along the line of bringing power and light frequencies and voltages into closer harmony, with consequent saving in apparatus and cost. This should be work for a special committee.

The report of the executive committee was presented by Mr. W. W. Freeman, and that of the treasurer by Mr. L. A. Ferguson. The report of the committee on meters, by Mr. J. W. Cowles, of Boston, chairman, was not given out. It included data on a number of tests, discussed the effects of shielding and unshielding, tilting from the level, etc., and stated that cheaper meters were a desideratum; but in view of the trend of legislation, the very best could be none too good.

Mr. F. P. Cox, of Lynn, Mass., presented an interesting paper on "Measurements with Portable Testing Instruments." It took up the points that arise in the use of such apparatus, under the several heads of potential, current, energy and time, with some remarks on care in use and transportation. Sources and causes of error were referred to, and it was shown that it would be alike unfair and impossible to effect laboratory accuracy under other than laboratory conditions. The paper was full of hints and practical suggestions.

Mr. John F. Gilchrist, as chairman of the committee on electric heating, presented a report of a most useful character, much of it dealing with the increase in consumption of electrical energy by families using devices for heating and cooking. Some special consumption data were embodied from Mr. A. A. Pope. The report illustrated and described some new devices, and then dealt with fields of work that are relatively unexplored or undeveloped. As a result of the report, the scope of the committee has been enlarged so as to embrace kindred and allied work.

This was followed by an anonymous paper from the Detroit Edison Company, on the subject of residence lighting in the city of Detroit, much of its data being that compiled and elaborated by Miss Sheridan. It attracted considerable attention and proved intensely interesting, especially as other cities were brought into the comparative study. The subject was treated under the heads of ratio of load to demand, period and hour of maximum demand, period of maximum annual sales, load factor, stability and extent of such business, effect of reduced rates, effect of differential rates, a study of rate methods, and net results. The conclusions of the report were that residence lighting, as in Detroit, has an annual load factor of 1000 hours now, and improving; a ratio approximately 1.4 to 4 for the sum of the individual monthly demand indicator readings of a group of 100 or more residences against the combined demand of the group—that is to say, a diversity factor of 1.4; also a high diversity factor against other classes of service such as office buildings, it coming later at night than they do. It was also held that electric lighting is without competition in fine residences, and will carry a price 10 to 20 per cent higher than gas in medium residences; while competing with gas and kerosene even in very small homes occupied by their owners. Residence lighting was held, in short, to be very desirable business under right conditions of density of service and moderate cost of construction, and ought to be encouraged also because of the parallel use of other electrical service. The report was accompanied by some striking news of residential streets in Detroit of a very modest cost, where every house is lighted electrically. One view showed a residential section of the city in which out of 3000 houses 2517 are illuminated electrically. Another view showed a street on which every house has electric lights and an electric flatiron.

The report of the committee on storage batteries was next presented by Mr. L. A. Ferguson, chairman.

Mr. Preston S. Millar, of the Electrical Laboratories, New York, presented an elaborate report in the shape of a review of the policies pursued by the Edison companies in regard to incandescent lamp matters, such as testing, rating, returned lamps, etc.

Mr. W. C. L. Eglin, of Philadelphia, chairman, presented the report of the committee on the National Electric Code. This committee has in hand a series of tests on better methods of grounding in suburban districts, and reported progress. With regard to grounding the neutral on alternating current circuits, the committee was unanimously of opinion that the secondary should be grounded on circuits of voltage below 150 volts, and should not be grounded on voltages above 250 volts. The report gave an account of recent agitation as to the revisions proposed of national code rules bearing on this general subject.

The evening session of Tuesday was devoted to the modern high efficiency metallic filament lamp, and brought out a wealth of material and discussion, the session lasting until long after midnight. Mr. John W. Lieb, Jr., led off as chairman of the committee on incandescent lamps, and, as usual, presented a most valuable report. Mr. John W. Howell read a paper on "Recent Developments in Metal Filament Lamps;" Mr. E. F. Tweedy read a paper on "The Probable Effects of the Higher Efficiency Lamp on Central Station Income," and Mr. M. S. Seelman, Jr., read a paper on "A Self-Supporting Tungsten Lamp Campaign." The whole subject was thus threshed over in a very exhaustive manner, and the discussion was of a most earnest and searching character. The Seelman paper directed attention to the action of the Brooklyn Edison Company, already noted in these pages, in organizing the Tungsten Lamp Specialty Company, launched with the object of securing as many sales as possible of tungsten lamp equipments among non-consumers. The paper gave full data as to the results of the campaign, including even the balance sheet of the subcompany, which has virtually won out already on a self-supporting basis in dealing with a highly complex problem.

The third session of the association began on Wednesday morning at 9:30 a. m., the program being: "Report of the Committee on Steam Turbines," Mr. C. N. Parker, chairman; "The Operation of the Boiler Plant and the Cost of Making Steam," by Mr. J. P. Sparrow; "Steam Heating from Central Stations," a supplement to his paper of 1907, by Mr. B. R. Fales; "Modern Substation Apparatus," by Mr. E. W. Allen; "Single versus Three-Phase Transformers for Distribution Purposes," by Mr. L. L. Elden; and "Short Circuits on Alternators," by Mr. E. J. Berg.

The fourth session was held on Wednesday evening, when Mr. W. F. Wells, chairman, presented the report of the committee on "High Potential Disturbances," which had been prepared with the co-operation of Mr. E. J. Berg and Dr. C. P. Steinmetz. The report was of a most interesting character and held that under the proper conditions 25,000-volt underground systems could be made commercial; that with present apparatus not above 50,000 kw should be concentrated on one set of busbars, and that reactances were desirable in series with turbogenerators. Attention was called to the phenomenon of "double voltage" on delta systems between conductors, and on Y systems between conductor and neutral point, and the necessity of providing for it in specifications. Dr. C. P. Steinmetz delivered a brilliant lecture on the "Electrical Enginering Problems of the Future," in which with wonted insight and intellectual grasp, he outlined the trend of coming events and the resources and restrictions of the art in meeting these newer opportunities and responsibilities.

The closing session of the convention was held on Thursday morning, Sept. 17, when the opening paper was read by Messrs. H. K. Mohr and J. D. Israel, of Philadelphia, on "Some Advertising Notes, with Particular Reference to the Value of a Display and Salesroom." This was effectively illustrated with views of the showrooms in Philadelphia, Rochester, Detroit, Scranton, Chicago, Boston and other cities, and a great deal of data was given as to the sales of miscellaneous apparatus as the result of advertising campaigns, and as to its kilowatt earning capacity. The paper included an account of a special

"raid" made by the General Electric Company in the upper Hudson Valley, and its excellent effect in the sale of flatirons, etc.

Mr. J. V. Oxtoby, of Detroit, then read a paper on "The Status of the Special Customer," which was a valuable discussion, chiefly from the legal standpoint, of the various services that a central station company is called upon to furnish. It dealt in detail with "breakdown" service in its different aspects; auxiliary peak service, auxiliary non-peak service, summer service, limited hour service, and non-peak service with the privilege of peak service. A number of legal decisions were summarized.

Messrs. E. M. Atkin and H. M. Edwards then presented a paper on "Compensation to Injured Employees—Plan of the New York Edison Company," accompanied by a letter from President Roosevelt expressing his interest in the data upon which the paper was based. As readers of the ELECTRICAL WORLD are aware, the company deals at first hand with the accident problem and is self-insuring, under a plan that has been in full existence since May, 1907, and which in the main has been found quite satisfactory. It is curious and rather disheartening to note, however, that in the three years of actual trial of the system no important suggestion has come from any employee as to possible improvement in "safety" conditions surrounding his work.

The exercises of the convention were brought to a close by an address on "Lighting in Europe," by Dr. Louis Bell, who, on behalf of the Boston Edison Company, has made a survey of the Continent, and, with the cabled consent of President Edgar, who is still there, presented a summary of his observations. The ELECTRICAL WORLD has recently printed a series of articles from Dr. Bell along the same lines, but in this address he went into many underlying details and charmed his auditors with a most brilliant and forceful analysis of international illuminating conditions.

The convention then elected Mr. W. W. Freeman, of Brooklyn, president, and General G. H. Harries, of Washington, D. C., vice-president. Mr. Mumford, of Detroit, continues for the present as secretary. An executive committee was also appointed.

A number of persons not connected with the association were present by invitation, including Professor Elihu Thomson, Dr. C. P. Steinmetz, Dr. A. E. Kennelly, of Harvard University, Mr. T. C. Martin, editor ELECTRICAL WORLD; Dr. Louis Bell; Commissioner Barker, of the Massachusetts Gas & Electric Light Commission. The General Electric Company occupied a large cottage adjoining the hotel, extended many courtesies and hospitalities, and was represented by a very large contingent, many of whom automobiled over from Schenectady, including Vice-Presidents Rice and Lovejoy, and Messrs. Rohrer, Emmet, Davis, Gilbert, Beran, Gale, Bates, Wagoner, Kimball and Willcox. The Stanley Works, at Pittsfield, were visited by all the delegates under the ciceroneship of Mr. Chesney and Mr. Joseph Insull, who directed special attention to the work in the electric heating department of manufacture. An old secretary of the association was also heartily welcomed in the person of Mr. W. S. Barstow. The Electric Storage Battery Company was represented by Messrs. Blizard, Taylor and J. Williams. Others in attendance were Messrs. Stephen D. Field and C. O. Baker. An enormous boon to everybody was the automobile service furnished by the General Electric Company, which brought over several machines from Schenectady for general use. The hotel stands on a mountain peak, and the autos did much to render it possible to get around from place to place.

As usual, a number of entertainments were given, including a golf tournament with several prizes, nearly all of which fell to Philadelphia. On Thursday afternoon an enjoyable reception was given at his beautiful Glendale estate, near Stockbridge, by Mr. R. R. Bowker, past president of the association, when Mrs. Bowker received in a big log cabin, assisted by Mrs S. D. Field Miss Field, and Mrs. D. French, wife of the sculptor. After tea in a pine grove, Mr. Bowker made a brief address of welcome, pointing out the scenic beauties and historical traditions of the region. In the evening a ball was given at the hotel, when the golf prizes were awarded, and when some excellent singing was enjoyed, notably from Mr. T. E. Murray, of New York. During the convention messages of a fraternal nature were received from the Vermont Electrical Association, then assembled at Bennington, about 40 miles away. It is only a matter of duty to add that much of the perfect success of the convention on the social side was due to Mrs. Dow, whose executive ability was manifested in the absolute smoothness and ease with which the various entertainments went off, due to her careful plans made days in advance and carried out to the letter.

Lenox possesses beautiful golf links near the hotel, and these were frequented all the time by members and especially by the ladies. The golf tournament took place on Wednesday and was greatly enjoyed, especially on account of the remarkable rules laid down by Mr. Dow, who drew up an ingenious code with diagrams that imported into the venerable game an air of novelty and levity rather startling to most of the participants wont to take their golf seriously. None but a man of Scotch extraction would have dared to take such awful liberties with the game, and very few Scotchmen could have been so funny over it. In the mixed foursomes, the ladies did all the driving off and all the holing out; the men played only the strokes through the green.

The new president of the Association of Edison Illuminating Companies, Mr. W. W. Freeman, was born at Exeter, Ontario, Canada, June 8, 1872. He was educated in the grammar and

PRESIDENT W. W. FREEMAN.

high schools of the Dominion, came to New York in 1889, and was made private secretary and stenographer to the general manager of the Edison Electric Illuminating Company of Brooklyn, then just starting into active existence. He has thus a continuous intimate acquaintance with the history of the corporation at every stage of its growth. He was next made assistant to the secretary and treasurer, retaining that position until 1895, when he was appointed assistant secretary. In January, 1898, he was elected secretary of the company, and was entrusted with its entire commercial development. He was soon after appointed as treasurer and elected a director. In June, 1905, he was elected vice-president and general manager, offices he has since held without interruption. Incidentally, he has held a number of kindred offices in other allied corporations, and is vice-president and treasurer of the Kings County Electric Light & Power Company, as well as director and treasurer of the Electrical Testing Laboratories. Mr. Freeman has always been active in the work of the Edison Association, and his election is viewed with much pleasure by his colleagues in that branch of the industry. He has also been an active member of the National Electric Light Association, of which he was secretary last year and is now second vice-president. Mr. Freeman has long been prominent in the social life of Brooklyn, and has served as president of the Congregational Club of that city.

Convention of the Colorado Electric Light, Power & Railway Association.

The Colorado Electric Light, Power & Railway Association held its sixth annual meeting at Hotel Colorado, Glenwood, Col., Sept. 16, 17 and 18. Both season and place were delightful for a convention.

At the first session, held Wednesday afternoon, President W. G. Matthews gave a brief review of the association's growth. It was organized in August, 1903, at Denver with 17 members. The first annual meeting was in October of the same year, at which time 37 members were on the roll. In 1907 there were 43 active members. At the present time there are 40 active members in Colorado and 10 from surrounding states.

The first paper was presented by Mr. S. E. Doane, chief engineer of the National Electric Lamp Association, on "The Newest Incandescent Lamps." He called attention to the 40 and 80-watt Gem lamps recently put out, which it is intended shall take the place of the old common carbon 16 and 32-cp lamps where the user does not want a lamp of higher candlepower.

In connection with the tungsten lamp, he urged that more emphasis be placed on the quality of light than has been. This paper brought out considerable discussion on the experience of members with tungsten lamps. On motion of Mr. F. W. Frueauff, of Denver, it was voted to appoint a committee to confer with the high-efficiency lamp committees of the National Electric Light Association and the Association of Edison Illuminating Companies. This committee as appointed at a later session consists of Messrs. F. W. Frueauff, of Denver; Geo. B. Tripp, of Colorado Springs, and W. C. Sterne, of Denver.

Wednesday evening a session was held to make up for the time lost by the lateness of the train which brought most of the attendants from Denver and the eastern part of the State. At this session Mr. J. C. Lawler, of the Colorado Springs Electric Company, read a paper on "The Operation of Hydro and Steam Plants in Parallel." This related to a peculiar set of conditions at Colorado Springs, but also had some general application and contained a timely warning as to prevision in water-power development. A large number of questions from the Question Box were then taken up, which occupied the remainder of the session.

Thursday morning the session was opened by a paper by Mr. John L. Mulvihill, of the Denver Gas & Electric Company, on "Popularizing of Public Utility Corporations by Careful, Painstaking Office Management." He gave some valuable suggestions from Denver practice and experience. Mr. George Raymond Hall presented a paper on "The Electrification of Steam Railroads Operating in Mountain Districts." After some discussion of this paper, the convention went into executive session.

Thursday afternoon an interesting paper was delivered by Mr. John A. Clay, of the Animas Power & Water Company, Silverton, on "The Lightning Arrester Equipment of the Animas Power & Water Company." This was probably one of the worst afflicted companies as to lightning in the country. Because of that fact it was selected for study and experiment by the General Electric Company, and its lightning arrester specialist, Prof. E. E. F. Creighton, spent the summer of 1907 there studying and experimenting on the lightning arrester problem.

From the records given by Mr. Clay on lightning troubles for several seasons past, it appears that the liberal use of the electrolytic arrester has almost eliminated shutdowns due to lightning. Many questions were asked Mr. Clay after this paper. This afternoon's session was closed by the reading of a paper by Mr. A. L. Eustice on "The Westinghouse Nernst Lamp; Its Value as a Business Getter for Central Stations." This was briefly discussed.

Friday morning the most of the session was taken up with the reading of a paper by Mr. Clarence Renshaw entitled, "Some Notes on Single-Phase Railway Systems." The author was not present. This went very thoroughly into the subject, showing the present state of the art.

The officers elected for the ensuing year were as follows: President, Mr. J. F. Dostal, Denver; vice-president, Mr. W. T. Wallace, Canon City; secretary and treasurer, Mr. J. C. Lawler, Colorado Springs. Executive committee: The officers, and Messrs. Geo. B. Tripp, Colorado Springs, and W. G. Matthews, Denver. Advisory committee: Messrs. John A. Beeler, Denver; W. J. Barker, Denver; John F. Vail, Pueblo; C. K. Durbin, Denver; John J. Cooper, Denver. Membership committee: Messrs. L. M. Cargo, J. C. Davidson, and C. H. Williams, all of Denver. Finance committee: Messrs. Irving Hale, Denver; J. A. Clay, Silverton; W. P. Eyre, Buena Vista.

In the afternoon the Central Colorado Power Company took the convention 11 miles up the Grand River from Glenwood to the place where construction is under way on that company's first great water-power plant. At that point the company is tunneling over 12,000 ft. along the side of the cañon to secure a head of 167 ft. and develop water-power for the operation of two 7000-kw units. Some of the steel towers and suspension insulators for the 100,000-volt transmission line to Denver and other points were also seen.

Mr. P. T. Hanscom, electrical engineer, and Mr. Geo. B. Tripp, manager commercial department, assisted by several other members of the engineering and construction staff, showed the party around.

The Sons of Jove held a rejuvenation Thursday night which is likely to go down in Glenwood history. Over 30 active members were present.

The Operation of Hydro-Electric and Steam Plants in Parallel.

Mr. J. C. Lawler, electrical engineer of the Colorado Springs Electric Company, read a paper on the subject of the operation in parallel of hydro-electric and steam at the convention of the Colorado Electric Light, Power & Railway Association at Glenwood, Col., Sept. 16, in which, after reviewing briefly the characteristics of various water wheels, he called attention to the necessity which has confronted many hydro-electric plants of installing steam auxiliaries and a large reservoir capacity. This arrangement has brought some new operating conditions which were not always in mind at the beginning of the enterprise. The necessity of reservoirs and steam auxiliaries plays havoc with the generation of cheap power and sometimes to such an extent as to warrant the utilization of a steam plant alone.

The first thing to be considered is the daily load factor of the system, and if this is less than 25 per cent, Mr. Lawler considers it better to operate entirely on steam; and if the hydro-electric plant complete lost twice that of the steam plant and coal costs $2 per ton, steam operation alone is the more economical. But if a hydro-electric plant of half the size could be built for less than one-half the money it might be advisable to operate it if this can be done continuously. Probably the greatest difficulty comes in determining the point to stop building additional reservoir capacity and to build a steam plant. The cost ratios given are not claimed by the author to be exact or to cover all cases. In practice it is found advisable to have the steam auxiliary located at the first distributing station of the system. This is the more important when the steam plant is not operated continuously, as the regular attendants can be utilized for operating it without extra cost.

The author then outlined the conditions at Colorado Springs, where a water-power plant feeds into one corner of a triangular-shaped transmission network, a steam plant located at coal mines feeds into another corner and an important substation is located at a third corner. Entirely unforeseen and unexpected droughts caused a lack of water recently and the steam plant is overloaded. At other times the steam plant has had to run so much underloaded that its cost per kilowatt-hour was excessive.

Dublin Meeting of British Association for the Advancement of Science.

By WILLIAM H. HALE, PH.D.

The fourth Dublin meeting of the British Association for the Advancement of Science, held Sept. 2-9, was in many respects notable. First, it was the largest gathering of recent years, the attendance, 2297, being several hundred in excess of that at Leicester in 1907, or York in 1906, and over 2000 larger than at Capetown in 1905, though not so large as at Dublin on the last preceding meeting in 1878.

Lord Lieutenant Aberdeen, the Governor of Ireland, vied with the Lord Mayor of Dublin in extending hospitality and in attending the meetings, while members of Parliament attending and participating were as plenty as blackberries. While the old sections—those of pure science—held their own, great interest was shown in the newer sections of applied science, viz., Economics and its subsection Agriculture and the newest of all, Education. The entertainment of members was royal throughout, every afternoon being occupied with one or more garden parties, and every evening either with a lecture or a conversazione or reception.

The meeting began on Wednesday evening when the president, Francis Darwin, son of Charles, in this the fiftieth year after the publication of his father's great work on National Selection, delivered his annual address on the "Movements of Plants" to a large and brilliant audience.

The work of the association has grown so vast that it became necessary to subdivide two of the sections; that of Mathematics and Physics was divided into the three departments of Mathematics, General Physics and Cosmical Physics, and the subsection of Agriculture was set off from the Economic Section, under the presidency of Sir Horace Plunkett, making altogether 12 separate sections simultaneously in session.

The few Americans present were more conspicuous than their number would indicate. Only 14 foreign members were enrolled, of whom two were from India, leaving not more than 12 from all America. Of these President George Bryce, of the University of Winnipeg, and Sir James Grant, of Ottawa, came to stimulate interest in the coming meeting to be held at Winnipeg on Aug. 25, 1909, bringing for distribution a profusely illustrated pamphlet, setting forth the attractions of that city, which has now a population of 110,000. Prof. J. C. Fields, of Toronto, read a paper on "The Complementary Theorem" to the Mathematical Section. Prof. W. H. Hobbs read a paper to the geologists on "Recent Changes of Level within the Basin of the Laurentian Lakes." Prof. Wm. M. Davis, of Harvard, gave one of the evening lectures in the Great Hall on "The Lesson of the Colorado Cañon," besides reading papers on "The Glacial Erosion in North Wales," and "The Physiographic Subdivision of the Appalachian Mountain System."

One of the evening lectures in the great hall of the Royal University was by Prof. H. H. Turner on Halley's comet, which he pronounces the most famous of all comets, because of the circumstances connected with the computation of its orbit by Halley. These computations have now been carried back to 240 B. C., and the comet identified as the flaming sword which hung over Jerusalem before its destruction as narrated by Josephus. It will not reach perihelion till April, 1910, but search for it has already begun.

The Section of Education was especially popular and the discussions took a wide range, being greatly stimulated by the renewed interest in education in Ireland, owing to the recent passage of an act of Parliament providing for two new universities at Dublin and Belfast. Dublin occupies a unique position, being the only city in the world which is the seat of two universities.

No review of the meeting, however cursory, would be complete without mention of the anti-tuberculosis campaign, the meeting for which purpose was presided over by Lord Lieutenant the Earl of Aberdeen; and the tuberculosis exhibition by Lady Aberdeen, who informed the writer that she will take it to Canada next year and she expects to attend the Winnipeg meeting.

Prof. Joly's presidential address to the Section of Geology on "Uranium and Geology" was pronounced by Sir Archibald Geikie "epoch-making," because it shows in uranium an inexhaustible source of radium, the intermediate product being ionium, as recently demonstrated by Goltwood. This provides a new source of heat so long postulated by geologists to account for the long eons of geologic time, which physicists cannot find in the gradual cooling of the earth, as it will be remembered that the late Lord Kelvin would not allow a longer duration of the cooling earth from the beginning of the geologic series than fifty million years, whereas geologists require fully one hundred million.

Prof. J. J. Thomson was elected president for the Winnipeg meeting, which was fixed for Aug. 25 to Sept. 1, 1909.

Sheffield was selected as the place of meeting in 1910 and Portsmouth in 1911.

Lord Rayleigh's Committee, which has charge of experiments for improving the construction of practical standards for electrical measurements, presented a long and detailed report, with appendices, of their work. The committee desire, in the first place, to record their deep sense of the loss they have sustained by the death of Lord Kelvin. He was an original member of the committee appointed at Cambridge, Oct. 3, 1862, and he continued his active interest in their work up to the end. His name will always be associated with the establishment of the absolute system of electrical measurement and with the determination of the absolute units. The reports of the committee from 1862 onward contain a large amount of valuable information in a form which is not generally very accessible—the reprint of the earlier reports, issued under the editorship of Fleeming Jenkin in 1873, is out of print—and the committee suggest that their reports from 1862 up to the present might be reprinted as a memorial to Lord Kelvin. The present time is in other respects specially suitable for such a reissue, for it is hoped that the proposed International Congress, to be held in London in October, will settle in a definite manner the few matters relating to the fundamental units which are still outstanding, and will organize a method whereby a close agreement may be maintained among the electrical standards in use throughout the world. The committee therefore recommended that their reports from 1862 onward be reprinted, after careful editing, as a memorial to Lord Kelvin, and that they be reappointed, with a grant of £100, for the purpose of undertaking this work and continuing their researches on the standards. This was referred to the council with a request that the republication be authorized as a memorial to the late Lord Kelvin.

The presidential address of W. M. Acworth to the Economic Section on "The Relation of Railways to the State," was a masterly paper, showing the difficulty of successful governmental ownership. The *Westminster Gazette*, reviewing it, editorially says:

"Among the many papers delivered before the British Association for the Advancement of Science yesterday, the first place in public interest must be given to that of Mr. W. M. Acworth, who discussed the relation of the State to the railways. The value of the paper is less in its conclusions than in the suggestiveness of its review of actual conditions existing to-day. So far the railway problem has been almost entirely discussed by partisan controversialists, and each side can, it may be admitted, find abundance of argument for any point of view, in the actual conditions existing in different countries. State ownership on the Continent has been attended by a lack of that vigorous enterprise which is found in some other countries. It has not been a conspicuous success in Australia. On the other hand, the highly organized private ownership of the United States has resulted in a condition of affairs in which the State control is frequently a little more than a mockery. Mexico has been responsible for an experiment on new lines in which a large proportion of the deferred stock is held by the State, thus giving the ultimate voice in direction, while in ordinary times the railways are run by the capitalists who made them. Mr.

Acworth thinks that the problem of State-ownership is more complicated the more the form of government departs from a bureaucracy and becomes legislative. That is unquestionably the case for State-ownership and creates a vast new body of voters who properly organized could swing the result of the election from one side to the other. On all these questions we want more exact information, and perhaps the most practical point of Mr. Acworth's paper is his appeal for the economists to give us a serious study of the transportation problem in its broad aspects."

Dugald Clark, president of the Engineering Section, in his presidential address after referring to the death of Lord Rosse, who had done much to perfect the steam turbine, gave a history of the development of the modern theory of heat engines. Referring to the internal combustion engine, this, he said, is the successor to the internal combustion motor, is the successor to the air engine, so fully discussed by eminent engineers of 55 years ago, and the forebodings of even so eminent a man as Faraday as to its ultimate success have proved unfounded. Great difficulties have been encountered, and many discrepancies have had to be explained, but a minute study of the nature of the working fluid has rendered it more and more possible to calculate the efficiencies to be expected under practical conditions. At the present time we can deal with almost any cycle or any working fluid with some fair approximation to an accurate result. Much work, however, is required before all problems of the working fluid can be said to be solved with regard to any heat engine. Indeed it may be said that under modern conditions of the use of steam, even the properties of the working fluid—steam—have not yet been satisfactorily determined. The mere question of specific heat, for example, of steam and its variations of temperature and pressure is now under review, and important experiments are in progress in Britain and on the Continent to determine those properties. The properties of the working fluid of the internal combustion motor are also the subject of earnest study by many Continental and British investigators. Notwithstanding all the perplexities involved in the minute study of the imperfect heat engine cycles, we are in a very different position to-day compared with the engineer of 1853. We know all the broad laws as to the conversion of heat into work, or of work into heat, and, numerous as are the problems yet to be solved, we at least profit by the guiding light set us by Kelvin, Joule, and Rankine.

The discussion of wave motion, opened by Dr. Horace Lamb, was not, as might have been expected, on undulations of light, sound or electricity, but related to the oscillations of the atmosphere.

Papers of more or less electrical interest were as follows: Discharge from Wehner's Cathode, by Dr. F. Horton; The Dry Daniell Pile, by John Brown; Further Experiments on the Constitution of the Electric Spark, by T. Royds; The Ionic Charge, by Prof. H. A. Wilson; Investigation of the Electrical State of the Upper Atmosphere, by W. Makower, Margaret White and E. Marsden; An Absolute Standard Voltmeter, by Prof. W. M. Thornton.

Sir Oliver Lodge, in conjunction with Mr. Benjamin Davies, submitted a paper on "The Measurement of Large Inductances Containing Iron." The authors had occasion lately to measure large inductances, up to and above 100 henries, with core consisting of subdivided iron in a nearly closed circuit, as used for certain telegraphic purposes with very weak currents. Since the inductance may vary rapidly with strength of current, it is necessary in any measurement to imitate the conditions of practice, and to determine the inductance as a function of current under those conditions. To this end a maximum-amplitude galvanometer was designed, consisting of a well-damped coil moving dead beat in a strong magnetic field, and attached to a mirror so that the amplitude of its excursion can be observed. It can subsequently be calibrated by means of a steady current giving the same deflection. The inductance to be measured is connected up in series with this galvanometer, and with a specially designed alternator of small power and known frequency, giving a sinuous or simply harmonic current. A switch allows the inductance to be suddenly replaced by a non-inductive adjustable resistance; and when under these conditions the same oscillation is produced in both cases, then the self-induction is equal to that equivalent resistance divided by the frequency constant. The strength of the current involved in this measurement is known by imitating the deflection with a known steady current; and the main measurement consists simply in observing the deflection caused by the sine-alternator, at a measured frequency, either with the inductance or with the adjustable non-inductive resistance, indiscriminately. The result of this method of measurement applied to inductance coils of this type shows (1) that measurements based on a determination of the square root of mean square of current would serve fairly well for low magnetizing forces; (2) that the self-inductance of such coils is for weak currents nearly independent of frequency, or say for all frequencies up to about 20 per second, when the magnetizing force does not exceed .04 c.g.s.; (3) that the self-inductance of a nearly closed magnetic circuit is a definite and dependable function of the width of the air-gap for moderate currents and frequencies.

Sir Oliver Lodge also delivered a lecture on "Electricity in Agriculture," reporting the work of his son and Mr. Newman, of Bristol, on the subject. The method adopted was to stretch wires over the field or in the glasshouses and to keep up such a voltage that on a dark night one could see a flow from the wires. Though the wires were at a considerable height from the ground, to allow wagons, etc., to pass beneath, a person could feel the hair of his head being stimulated, or as if a cobweb was on his face. Whether it was an electric massage applied to the plants or how it acted he could not say. But there was something in it. It did plants good, and it increased the yield and brought them on more quickly. Whether it was too great an expense in the long run, or whether it exhausted the plant or the soil, were also matters for inquiry. It appeared to be unwise to apply electricity in dry weather or strong sunlight, because the effect was to overstimulate the plants; but in dull and damp weather the electrical stimulus seemed to be efficacious. It had been applied to almost all kinds of plants—wheat, strawberries, various other kinds of fruit, cucumbers, tomatoes, beans and peas. In these last two and other leguminous plants it appeared to be deleterious; it diminished the yield of beans. In the rotation of crops these were used to put something back into the soil, and the difference of the effect of electricity in their case was worth noting. He pointed out that in these experiments they supplied positive electricity to the plants; they emphasized the natural electrification of the air, so that the plants from every point gave off negative electricity—fizzing it off, as he had described. Naturally, the plant would be doing that, but they artificially stimulated it to do a little more. Negative electricity applied to plants was supposed to keep them back. Electrification was easier in greenhouse crops. An oil engine of 20 hp was sufficient to drive a dynamo for 20 acres. The wires were on poles, about one pole to the acre, and across these were stretched thinner wires, forming a sort of grating over the crop. They found that the difference in wheat was 30 to 35 per cent in favor of the electrified crop, and the quality of the flour was specially good. There was more straw and bigger and fuller ears. The effect of electricity had even been observed in the extra growth of the hedge of the field at one point. The first cost might be about £300. What was needed was to ascertain the effect of this electrification from year to year.

Mr. Priestly (Bristol University College) said he was at first a skeptic in this matter, but he had been convinced there was something in it. The difference in strawberry plots was as much as 90 per cent. There was no doubt it accentuated the production of the crop; electrified cucumbers were a week ahead of the others.

Nitrates seemed to be added to the soil by the electricity. The plants so treated were of a darker green, which was one of the results of over-nitration of the soil.

Professor Barrett (Dublin) said that Mr. O'Sullivan, post-

master at Athy, had conducted experiments, and he (the speaker) repeated them. The wires were 2½ ft. above the ground, and there was no dynamo; it was atmospheric electricity. The increased yield the first year on potatoes was 20 per cent, but the second year there was no difference between the crops with and without wires. Since it had been begun, as described by Sir Oliver Lodge, to use a current from a dynamo, the matter was on a new plane altogether. He thought the explanation might be found in the effect of electrical discharges upon minute forms of life.

Mr. Gerald Stoney, M. Inst. C. E., read a paper dealing with recent advances in steam turbines. He pointed to the rapid progress that has been made in steam turbines during the past two years. Improvements in electric machinery, both in the form of continuous-current dynamos and also alternators driven by steam turbines, were dealt with, as well as the application of the steam turbine to air compressors and for pumping water, etc. The use of exhaust-steam turbines for utilizing the exhaust from reciprocating engines was described, and also of intermittent supplies of exhaust steam, such as from winding-engines, by help of thermal accumulators, along with the further refinement of mixed-pressure turbines, where, when the supply of exhaust-steam fails, a high-pressure portion is brought into action, thus utilizing the full boiler pressure. Improvements in condensers and the various means to obtain the highest vacuum possible were also described. In marine work the great development of express liners on the Atlantic was dealt with, and also the combination of reciprocating engines and turbines for tramp steamers and vessels of low speed, from which combination greater economy can be obtained than with either steam turbines or reciprocating engines alone. It was satisfactory to know that the turbines of the great Atlantic liners were successful in every way. There are at present 2,000,000 hp of turbines afloat.

Whether transportation (or traction) on the surface in towns is best accomplished with or without rails, was dealt with in a paper read before the Engineering Section by Mr. F. Douglas Fox, M. Inst. C. E. The question, Mr. Fox said, has yet to be solved by actual experience. The principal technical points to be considered were, he said, simplicity of mechanism, ample capacity, speed, power of rapid acceleration, comfort and convenience, and moderate capital expenditure and cost of operation. In recent private enterprises in urban traction there had been until lately no attempt at comprehensive treatment, and, in addition, the competition had been disastrous. London, he remarked, still required a Central Board of Traffic, and he hoped that engineering, as applied to the transport traffic of the future, would become more and more an exact science, and so avoid the great barrier to progress—waste of capital.

Stanislaus (Cal.) Power Plant Is Nearly Ready.

Early in October the Stanislaus Power & Electric Company, which has been constructing in California one of the most extensive systems and longest transmission lines in the world, will commence supplying electricity for the mines in Calaveras, Tuolumne and other counties. Later it will supply the cities around San Francisco with electrical energy. The wires have been strung through San Joaquin County and the men are at present working in Alameda and Contra Costa Counties. The principal part of the work was done by the Union Construction Company, and it is estimated that when the plant is placed in operation about $16,000,000 will have been spent. It has been an unusually large undertaking and at one time work had to be suspended owing to the failure of the Knickerbocker Trust Company, of New York, N. Y., which was financing the proposition. One of the largest dams in the world is being constructed at Camp Relief, in Tuolumne County. Fifteen feet more will be added to the structure this season or before heavy snows set in, making it 70 ft. in height. When completed the dam will be 165 ft. in height from the base of the creek and the width of the top will be 700 ft. The company has placed steel towers at a distance of 800 ft. apart through Tuolumne, Calaveras and San Joaquin Counties, and is now working in Alameda and Contra Costa Counties. From arms they carry three power wires with a total of 85,000 volts and protected by water shields.

Electrical Conveyors in the Yukon.

The second of the Yukon Gold Company's electrical conveyors was started on Bonanza Creek, in the Yukon, several weeks ago. The material for the plant was in Dawson City early this year, but none of the assembling was attempted until June. The fitting up of this conveyor was accomplished in much shorter time than that of No. 1. This conveyor, like the first one, has a nominal capacity of 3500 cu. yd. every 24 hours. The third of these electrical conveyors is now being installed at No. 23, below Bonanza, and it will be in operation before the end of September. Robert Moncrieff, of Dawson City, has had immediate charge of the construction of the conveyors, the first of which is proving eminently successful.

CURRENT NEWS AND NOTES.

TELEPHONY ON RAILROADS.—It is stated from Chicago that 18 heads of telegraph departments of the largest railroads west of the Ohio River have expressed themselves in favor of the substitution of the telephone for the telegraph in dispatching and block signaling, as far as possible.

ELECTRIFICATION OF ILLINOIS CENTRAL CHICAGO TERMINAL.—President Hanrahan has started energetically to work on the preparation of preliminary plans for the electrification of the Chicago terminal of the Illinois Central Railroad. For this purpose special experts will be engaged to co-operate with the engineering staff of the road.

ST. PAUL ROAD ELECTRIFICATION.—The St. Paul Railroad directors held their annual meeting at Milwaukee, Wis., on Sept. 19, when, it is stated, they discussed among other subjects the electrification of the Pacific Coast lines. In this and other matters definite action is deferred until the meeting of the executive committee of the board later in the year.

AN ELECTRICAL KNIFE FOR SURGERY.—A special cable dispatch from Berlin of Sept. 19 says: "Surgery by electricity is what is alleged to be possible with a remarkable electric knife just devised by a Berlin firm of medical instrument manufacturers. The knife is now undergoing exhaustive trials at the hands of Professor Bier, the head of the university surgical clinic, with the view of demonstrating its efficacy. It is claimed for it that operations can be performed more quickly and that the healing process is more rapid than in the case where the ordinary scalpel has been used. To one end of a 6 or 8-in. glass rod, through the center of which passes a conducting wire, is fastened the blade without a cutting edge of a form similar to that of the commonly used surgical knives or like the simple probe. A high-frequency current is employed, and, when this is turned on, a noiseless spark half an inch long appears from the point of the knife or probe. The spark incises the soft tissues with the same ease as a hot knife goes through butter without any apparent cauterization, but Professor Bier's experiments have so far shown that a more profuse hemorrhage ensues than by the use of the common knife. It is further claimed for the instrument that it sterilizes as it cuts, requires no sharpening, and can be easily cleaned."

WIRELESS TYPE-SETTING.—A demonstration was given last week in London of an invention by Hans Knudson, a Dan-

ish electrical engineer, whereby the keyboard of a linotype typesetting machine is operated from a distance by wireless telegraphy.

WIRELESS NAVAL TORPEDOES.—Boston newspapers report that the Navy Department is negotiating with Charles A. Logue, of Charlestown, a third-year student at the Boston University, for the right to use a system of his invention for the wireless control of torpedoes.

NEW GERMAN CABLE.—The German-South American Telegraph Company has been organized in Berlin, with a capital of 4,000,000 marks, for the purpose of laying cables to South America, the first of which will land in Brazil. The cable will be supplied by the Felten, Guilleaume-Lahmeyer Company.

WIRELESS AND AERONAUTICS.—Mr. George C. Boldt, proprietor of the Waldorf-Astoria, New York, and of Hotel Bellevue-Stratford, Philadelphia, has offered to set up wireless apparatus on the Wright aeroplane at Fort Myer, and also the use of his two hotel wireless plants for experiments in wireless communication with the aeroplane.

NEW TECHNICAL SCHOOL FOR IPSWICH, MASS.—By the will of the late John B. Brown, of Chicago, the bulk of his wealth, estimated at $7,000,000, is to be devoted to establishing and maintaining a technical school at Ipswich, Mass., where the testator had large holdings of real estate. The underlying principle will be the furnishing of instruction at the lowest possible cost. A high-school education or its practical equivalent will be prerequisite for admission, thus placing the school among the higher institutions of learning. There are to be no restrictions as to sex, color, race, religion or politics. The funds will be controlled by trustees, one of whom is Judge Sayward, of Ipswich. He states that the school will probably resemble a combination of the Massachusetts Institute of Technology and the new school of business administration at Harvard University.

ELECTRICITY IN THERAPEUTICS.—A special cable dispatch from Paris of Sept. 19 says: "A young American woman, Dr. Louise Rabbinovich, the only woman member of the faculty of the Pasteur Institute, is about to be associated with a most important experiment in pathology. Her very brilliant work with electricity as an anæsthetic has impressed the members of the institute to such an extent that an operation will shortly be performed with its aid. It has been found that by applying interrupted currents of electricity to the human body a state of complete anæsthesia can be produced which does not affect the action of the heart. In view of the fact that the use of chloroform and all drug anæsthetics must inevitably cause a risk to the heart action, this discovery in electricity is of the greatest moment to surgeons. Dr. Rabbinovich will act as anæstheist at the operations."

MARCONI ON WIRELESS.—In an interview last week Mr. Marconi stated that at present he is planning to do nothing with the Marconi station at Cape Cod, attention being concentrated on the more powerful stations at Glace Bay, Nova Scotia, and that at Clifden, Ireland. Reserve apparatus is now being installed at Glace Bay, duplicating the present equipment there. About 100 hp, he stated, is required for transatlantic communication. At present no attempt is made to send more than 20 words a minute. He said the statement that an operator at Los Angeles picked up a message from Admiral Sperry's flagship, 2000 miles distant, is not incredible. Mr. Marconi stated that after long-distance stations on the Atlantic are fully equipped, thought will be given to a transpacific service, and he believes that the Pacific can be spanned from shore to shore without oceanic relay stations.

TELEPHONE FIRE IN PARIS.—The Paris central telephone exchange and the postoffice, near the Place des Victoires, were totally destroyed by fire on Sunday, Sept. 20. The origin of the fire is a mystery, but incendiarism is suspected, the government having had considerable trouble lately with striking electricians and linemen. The loss is estimated at $5,000,000. The 200 employees in the building had difficulty in effecting their escape. Some 20,000 lines are thrown out of service, including all the most important ones in the city. The exchange was relatively new, on a limited common-battery system. It is thought that not less than one month will be needed to re-establish service even temporarily; and the fire is likely to result in the construction of the larger system on the measured-rate basis now under contemplation.

NEW YORK ELECTRICAL SHOW.—As president of the commemorative electrical show to be held in Madison Square Garden, Oct. 3 to 14, inclusive, Mr. Thomas A. Edison has written a letter to the management in which he says: "I find myself in hearty sympathy with this project, primarily as an old telegrapher, and, second, because ever since the fall of 1882, the successful demonstration associated with my name here, of what electricity can do to furnish light, power, heat and other service to the public from central-station mains, has been a continuous gratification to me. As one whose efforts were directed steadfastly to that end, with New York as the starting point, I am naturally glad to see that importance is also attached to that achievement and anniversary. I appreciate deeply the request that I accept the honorary presidency of this notable exhibition, and feel that under the circumstances it is my duty thus to associate myself with the celebration. I can only hope that during the next 50 years the arts to which I and my co-laborers in the electrical field have devoted our lives may be attended with even richer benefits to mankind. We have but opened the way for our successors, whose brilliant work is already beginning to occupy the new era." The Metropolitan Museum of Art is loaning to the exhibition its unknown but very fine collection of Field memorials, medals, pictures, etc., connected with the laying of the Atlantic submarine cables of 1858 and later years.

AN INVENTOR WHO DESIRES AID.—We have received a communication from an inventor who desires "some institution" to take up an invention of his which, he says, will be of the highest benefit to mankind. The idea, he says, is very simple, consisting in the use of a captive balloon at an elevation of about 300 ft., from which is suspended a windmill consisting of thin blades of steel and iron covered with fine copper, iron and silver wire. This windmill is connected to a small dynamo, also suspended from the balloon, the current from which is conducted by a three-strand cable to about 20 ft. above the surface of the earth, where the cable end is secured to three insulated guys. To the cable end is then connected a number of fine wires, which form a canopy over the head of a person standing on a platform of wood elevated about 6 ft. from the earth. A piece of iron 4 ft. square is secured to the top of the platform and connected with a piece of iron 10 ft. square buried 20 ft. deep in the earth, the connection consisting of 100 small insulated wires. The person to be treated stands with bare feet on the iron platform, the wire canopy is lowered until it almost touches his bared head, the wind revolves the wheel, the dynamo generates electricity, which runs down a cable to the wire canopy and thence is drawn through the body of the subject into the earth. The claim is made that the electricity in passing to the earth will draw the pains and aches from the bones, muscles and cords of a human body and will greatly help, if not cure, all kinds of nervous diseases, rheumatism, etc., as it is well known that electricity drawn from the air is milder and in more natural form than the kind generated by electric medical machines. It is estimated that the whole apparatus could be made for from $800 to $1,000, the contribution of which is asked as an aid to suffering mankind.

Turbo-Generator Plant of the United Electric Light Company of Springfield, Mass.

THE United Electric Light Company, of Springfield, Mass., recently placed in operation a 2500-kw steam turbo-generator plant which will have ultimately a 10,000-kw equipment. The addition to this station makes the total generating rating of the system 11,300 kw, or 18,880 kw ultimately. The plant cost approximately $300,000, and was first placed in commercial service about Aug. 14. It is located on the east bank of the Connecticut River in the central portion of the city, and adjoins the existing steam-generating station of the company known as plant No. 1. The rating of the latter plant is 3800 kw. The company also owns and operates a 1000-kw hydro-electric plant at Birchem Bend, and a 4000-kw hydro-electric station at Indian Orchard. All of the latter plants and their operation have been described in previous issues of the ELECTRICAL WORLD.

The new station building is a brick structure with concrete foundations laid on piles. The floor of the basement is about 8 ft. below the river level, and the concrete course beneath is 2 ft. thick. The building is 113 ft. in length, and is divided into a boiler room, 60 ft. wide, and a turbine room, 80 ft. wide. Beneath the latter is a basement 19 ft. high. A fireproof wall separates the boiler and turbine rooms.

The boiler room contains at present six 400-hp Hazelton vertical boilers, equipped with Murphy stokers. Each boiler is provided with a steel stack 48 in. inside diameter and 30 ft. in height above the top of the boiler shell. Coal is supplied to the plant from a locomotive-type electric crane, which delivers coal to the old plant as well as to the new one from cars brought to the station by the New York, New Haven & Hartford Railroad. The crane, which was built by the Industrial Iron Works, of Bay City, Mich., is of the radial jib type, reaching both the station storage yards and the hoppers of the conveying systems which have been installed. In the new plant the scale. The elevator is of the chain-bucket type with 12-in. x 16-in. buckets, and it is driven by a 10-hp, 500-volt direct-current motor. The elevator buckets are carried in a steel casing, and the coal-handling apparatus as a whole, beyond the first delivery hopper at the locomotive crane, is enclosed in a corrugated-iron housing. After the coal has been weighed on the

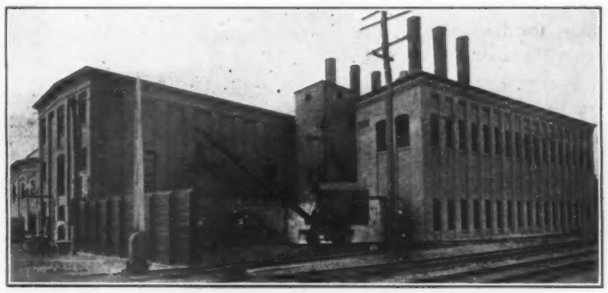


FIG. 2.—COAL-HANDLING ELECTRIC LOCOMOTIVE CRANE.

automatic scales, it is discharged upon a horizontal 16-in. belt conveyor of the Robins type, driven by a 10-hp, 500-volt motor. This conveyor carries the coal to the firing hoppers of the different boilers and can be set to discharge automatically at any desired point. The action of the grates is practically smokeless under all operating conditions. The system can handle 50 tons of coal per hour.

Beneath each boiler is a chute delivering ashes into a small handcar running transversely across the plant. The ashes are placed in a hopper set onto the floor at one end from which they are carried into a vertical ash elevator operated by a 10-hp motor, which conveys them to an overhead storage pocket, 23 ft. high and 12 ft. square. The bottom of this pocket is located 8 ft. above the grade of the street, and when the pocket is full, in part or wholly, teams are driven under the

FIG. 1.—INTERIOR OF TURBO-GENERATOR ROOM, SPRINGFIELD, MASS.

crane delivers the coal to a steel hopper located at the ground level, the hopper being 12 ft. wide by 15 ft. long and braced by steel framing anchored into concrete foundations. From the hopper the coal passes into a crusher driven by a 20-hp, 500-volt direct-current motor, after which it is carried upward by an elevator and delivered through a spout into a 1000-lb. automatic bottom of the pocket, and the ashes are discharged by gravity for hauling away. These arrangements for the handling of fuel and ashes make the operation of the boiler room practically as clean a task as the handling of the turbines and pumps. The boiler room is painted white.

Feed water is supplied through an 8-in. main which forms a

complete horizontal loop around the batteries. Each boiler delivers steam at 150-lb. pressure without superheat at present into a 5-in. line which joins to a 12-in. horizontal steam header located about 8 ft. above the floor parallel to the turbine-room wall. The boiler-feed pump installation consists of a Deane compound-duplex outside-packed-plunger unit, supplied with steam through a 2-in. line. The feed pump is located in the turbine room, together with an extensive filtering apparatus installed by the New York Continental Jewell Filtration Company.

The filter plant consists of a steel-banded cypress tank 12 ft.

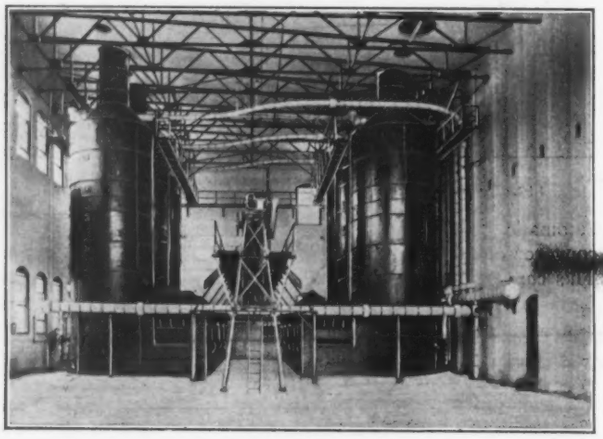


FIG. 3.—BOILER ROOM AND COAL-HANDLING EQUIPMENT.

in diameter and 16 ft. high. The water is introduced into a lower chamber in the tank where it assumes a rotary motion and passes upward through a pipe, discharging upon the sand of a filter bed. After filtering through this bed, the water is carried out through a strainer system to a controller, which regulates the flow so that the holding capacity of the filter may not be overtaxed. Agitators are provided for washing the tank; when water under pressure is forced up through the strainer system the sand which is being scoured by the agitator will be

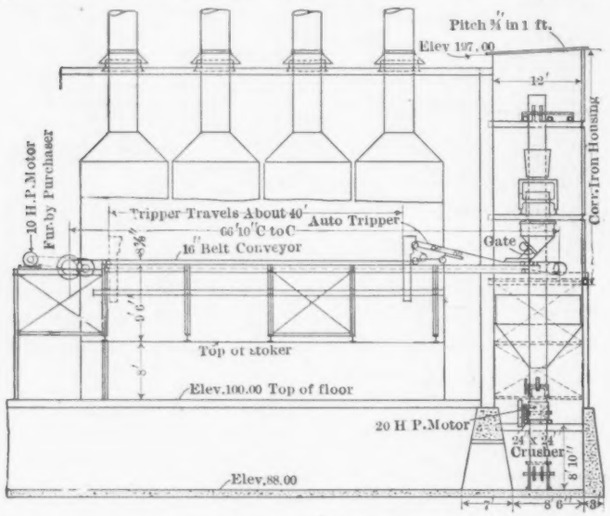


FIG. 4.—SECTIONAL ELEVATION OF BOILER ROOM, SHOWING COAL-HANDLING ARRANGEMENT.

lifted, flushing off the impurities into a gutter connected with the sewer. The agitator is operated by a 500-volt, 8.5-amp motor. From the filter the water is pumped into a 6000-hp vertical National feed-water heater located in the turbine room. A main storage tank for filtered water is provided in the basement, being 30 ft. long and 6 ft. in diameter. An extra pump is installed in the basement for the purpose of supplying water to either the filter or the boiler-feed line. The water supply is drawn from the Connecticut River, the lift being about 20 ft.

One turbine is installed at present in the plant, although the building has been constructed to its final dimensions on account of the extensive foundation work demanded, and the desirability of not interfering later with regular operation when more equipment is needed. The present installation consists of a 2500-kw, two-phase, 60-cycle, 5600-volt Westinghouse-Parsons turbo-alternator, making 1200 r.p.m. It is of the enclosed type, cooled by air drawn in from the outside of the building near the basement through a 4-ft. x 6-ft. galvanized iron duct, a second duct being provided for the egress of the warmed air. Fan blades on the turbine shaft provide for the necessary circulation. The turbine is excited by a 35-kw, 125-volt generator mounted on the same shaft at the end of the machine nearest the river. Steam is supplied to the turbine through a 9-in. main leading through the fire-wall from the boiler-room header. Electrical connection with the generators in the old station enables the alternators to obtain excitation current in starting up.

The condensing apparatus for the turbine differs considerably from the usual types of apparatus for similar service. After a thorough investigation of the merits of the various types of condensing outfits it was decided to install motor-driven auxiliaries. It was felt that the economy of this method, where [illegible] is not needed for the feed-water heating, is unquestionable. At this plant energy is always available for the operation of motors, so that the reliability of the apparatus is insured. The specifications called for a vacuum equivalent to 28 in., with a 30-in. barometer, necessitating the use of a dry-vacuum pump to remove the air from the condenser. The condenser is of the counter-current Deane jet type. Exhaust steam enters at one side through a short elbow connected to the exhaust outlet of the turbine. The exhaust connection is provided with a motor-operated gate valve of Chapman make, the motor being a 3-hp, 500-volt direct-current machine. This gate valve is closed when the turbine for any reason is run non-condensing. A 24-in. free exhaust pipe provides for the latter condition. The injection water, taken from the river through an 18-in. main, enters at the top of the condenser and is broken up into small drops by a perforated plate. The water is removed from the condenser by a centrifugal pump, and the air is taken out through a cooler at the top by the dry-air pump. The wet pump is a 16-in. volute machine, directly connected

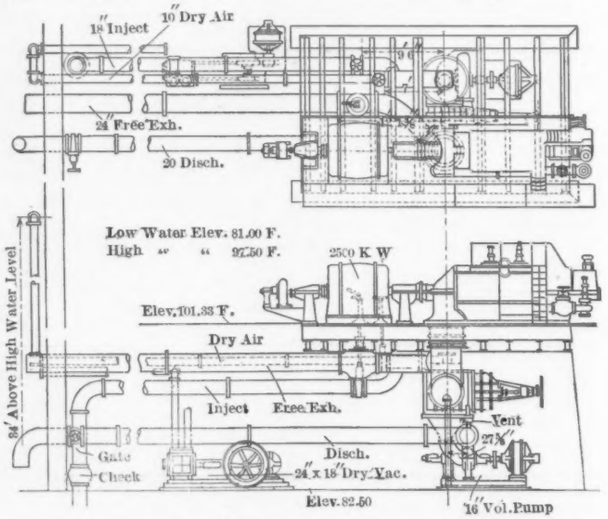


FIG. 5.—ARRANGEMENT OF TURBINES AND AUXILIARIES.

through a flexible coupling to a 95-hp motor of the General Electric 2300-volt, two-phase induction type. The dry-air pump is a single-cylinder horizontal-fly-wheel machine, 24 in. x 18 in., connected through a single reduction gearing to a 45-hp, 2300-volt, two-phase General Electric induction motor. There is a by-pass port in the main valve of the air pump for the purpose of reducing the pressure in the clearance and thus giving maximum efficiency.

The centrifugal pump is easily primed by opening the injection valve and starting the dry-air pump. The outfit makes a

very simple condensing apparatus, easy to operate, reliable and of comparatively low first cost. Preliminary tests of the apparatus have shown a better vacuum than is called for by the contract. Water for the turbine glands, cooling purposes, etc., is supplied from a tank located on the roof of the station. A pump in the basement delivers water to this tank for storage. An automatic Squires governor is installed in connection with the supply of feed water for the boilers. The plant is also equipped with the Holly gravity drip system. The turbine room is lighted by 160 25-cp incandescent lamps installed about 7 ft. apart on the roof trusses, and on the walls are installed 14 enclosed-arc lamps on brackets. A 25-ton Niles hand-controlled crane serves the entire length and width of the turbine room. At present the output of the new turbine is controlled from the main alternating-current switchboard of the old plant. The station is in charge of Mr. Walter H. Damon, superintendent of generating. Mr. W. L. Mulligan is general manager of the company.

The Electrical Equipment of the Dan River Power & Manufacturing Company.

BY N. H. SLAUGHTER.

THE cotton-manufacturing plant of the Dan River Power & Manufacturing Company, located two miles west of Danville, Va., on one of the main lines of the Southern Railway System, is a striking example of the industrial progress now going on in the Southern States. As regards output, the plant compares favorably with the largest cotton factories in the South, operating as it does 90,000 spindles, and in economy of operation it is probably surpassed by few in the whole country, North or South.

Nearly all of the 1600 employees of the company, with their families, reside in the immediate vicinity of the plant, in neat, substantial houses built by the company and rented to the employees at a very low rate. Water is furnished them free from a system owned likewise by the company, while the streets of the little town are lighted with electricity at no cost to the inhabitants.

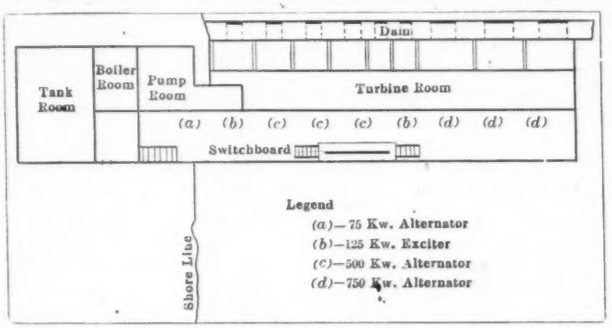
From an electrical standpoint the equipment of the plant, while conforming to standard practice in such plants, has some interesting features. All of the machinery in the various buildings, with the exception of a few steam-driven ventilating fans, is electrically driven, the energy for the motors and for lighting the buildings and the streets of the town being furnished by a hydro-electric station on the Dan River, about a half mile north of the cotton factory. This station is owned and operated by the company, which uses the output solely for lamps and motors for its own plant and the town inhabited by its employees. The total output of this station is about 4000 kw, which is more than ample for the present needs of the plant, but in times of low water the output falls below 3000 kw, which is less than the present maximum load on the station, so to provide for such emergencies a 1500-kw steam turbo-alternator is soon to be installed at the factory grounds.

The power station is built just behind one end of a concrete dam which extends from the comparatively high banks on the south side of the river (where the power plant is located) across the stream and a stretch of low land to the opposite hills. The dam has a total length of 900 ft., with a 600-ft. spillway. Its height is 25 ft., except at the bulkheads, where it is increased to 35 ft. This height gave originally a storage area of several hundred acres, which would have greatly increased the available power, as the plant operates only about 12 hours a day, but this storage area is being rapidly destroyed by the deposit of sediment.

The power station, which is largely concrete also, has a length along the dam of about 250 ft. and an average width of 50 ft. There is, in addition to the generator and turbine rooms, a section devoted to the water-supply system, comprising a pump room, boiler room and a tank room. The pump room contains a turbine-driven triplex pump capable of delivering 1,000,000 gal. of water a day at a pressure of 140 lb. per square inch. An auxiliary steam pump, supplied with steam from a 50-hp Wilson boiler, is also provided. The tank room contains several large wooden tanks in which the water from the river is purified before being pumped into the reservoir.

The turbines, of which there are eight altogether, are Hercules horizontal machines, each turbine consisting of two pairs of wheels on the same shaft. The normal head is 25 ft. The generators, which are direct-connected to the turbines, are three-phase, 6600-volt, 25-cycle, revolving-field alternators. There are three 750-kw, 150-r.p.m. machines and three 500-kw, 187½-r.p.m. machines. The exciters, two in number, are each 125-kw, 125-volt machines; either one can supply all the field current needed by the generators. At the end of the generator room, adjacent to the pump room, is a 75-kw, three-phase, 60-cycle, 2300-volt lighting machine, used to supply energy for the street lamps and other lamps about the plant. This machine is the only belt-driven generator in the station, being run from one of the exciter shafts. The turbines are equipped with the "Improved" governor, manufactured by the Holyoke Machine Company, and very good regulation is obtained with these governors.

The switchboard is located on a raised platform, with space beneath for field rheostats, small transformers, etc. The board has 10 panels, distributed as follows: six machine panels, two feeder panels and two exciter panels. Just to the right of the board is a small panel for the lighting generator. Each machine panel is equipped with three ammeters, a field ammeter and rheostat, and an indicating wattmeter. Only two voltmeters are provided for the whole board, one for the busbars, the other having connections to each machine panel, where plugs are



FLOOR PLAN OF GENERATING STATION.

used to complete the voltmeter circuit. The feeder panels are equipped with automatic circuit-breakers, static ground detectors, two on each panel, and polyphase watt-hour meters. At one end of the board are located a power-factor meter and a synchronoscope. On one of the exciter panels is a recording voltmeter of the Kelvin balance type. The generators are all delta-connected with the exception of the small lighting generator.

The transmission line is composed of two independent three-phase circuits, the three large generators supplying one circuit and the three smaller ones the other circuit. No. 0000 bare copper wire is used, and as the transmission line is less than 2500 ft. long the energy lost in the line is very small, indeed, being less than 1 per cent.

The transformer house, located just within the factory grounds, contains two banks of delta-connected transformers, with switches for parallel operation of the two banks. One extra transformer is provided for emergencies. The transformers are each 600 kw, stepping the line voltage down to 440 volts, at which pressure the current is supplied to the motors in the various buildings. Two 200-kw transformers, which step the line voltage down to 110 volts, are used to supply energy to the lamps in the buildings. A switchboard is provided with two line panels and feeder panels for the various motor and lamp circuits.

The motor equipment of the plant consists of three-phase, 440-volt induction motors in sizes ranging from 30 to 150 hp, most of them being 75, 100 and 150 hp. Auto-transformers are used for starting, and as the motors usually start without load, the starting current is not abnormally large. The motors run most

of the time well loaded, hence their power factor and efficiency are, as a rule, high. When the machinery is stopped during the noon intermission, the motors are usually left running, the friction clutches connecting the motor to the machines being thrown out. The power factor then drops to about 50 per cent, whereas normally the station meter shows a power factor of about 82 per cent.

The plant is run only during the day, from 7 a. m. to 5:30 p. m., the only machine run at night being the lighting generator. The load is practically uniform throughout the day, so the station operator can run the required number of generators well-loaded, thus securing good efficiency of the generating apparatus. Usually all of the generators but one are run throughout the day. Lamps are used in addition to the synchronoscope for synchronizing, low-voltage current being supplied through transformers and connections being so made that a dark lamp indicates the proper moment for paralleling the generator with the busbars.

The turbo-alternator soon to be installed at the factory will comprise a 2000-hp steam turbine, direct-connected to a 1500-kw, three-phase, 440-volt, 25-cycle alternator. The turbine will be supplied with steam at 175-lb. pressure from a battery of Stirling water-tube boilers. At present only 1000 hp in boilers is being installed, as it is not intended to operate the turbine at its full capacity for some time. The alternator will be paralleled with the water-power station on the low-tension side of the transformers.

The street lighting is accomplished by means of series incandescent carbon lamps of 50 cp placed at frequent intervals along the streets. The lamp circuits are supplied from the 2300-volt alternator, each lamp requiring 100 volts and the current in each circuit being 1½ amp. There are also constant-potential incandescent and arc lamps within the factory grounds supplied from the same alternator through transformers.

The above plant has been in operation for several years; its present capacity, however, was reached only during the past year by almost doubling the original equipment.

The electrical equipment of this plant was furnished by the Westinghouse Electric & Manufacturing Company; the turbines by the Holyoke Machine Company, and the steam turbine and alternator will be furnished by the Allis-Chalmers Company. The officers of the company are: R. A. Schoolfield, president; J. H. Schoolfield, vice-president; H. R. Fitzgerald, secretary and treasurer. The writer is indebted to Mr. Nelson, in charge of the water-power station, for the information presented in the above article.

Influence of the Slot-Ratio Upon the Starting Torque of Induction Motors.

By R. E. Hellmund.

It is well known that the starting torque of induction motors varies more or less with the position of the rotor. In the issue of the Electrical World for March 31, 1906, the writer pointed out that these variations are caused partly by the changes in the leakage flux. For uniform starting torque the motors should, therefore, be built so that the variation of the leakage flux is as small as possible. In squirrel-cage motors the zigzag leakage flux is the only flux which may change considerably with alteration in the position of the rotor. It was pointed out years ago by engineers that the variations of the torque are the smaller the smaller the greatest common divisor between the stator and the rotor slots.

As the result of a number of calculations concerning the variation of the zig-zag leakage for various slot-ratios, the writer has found that, although the exceedingly large number of possible combinations and the large variety of conditions which are possible with the different combinations make a general proof almost impossible, it may be safely concluded that in general the variation of the zig-zag leakage is the smaller the smaller the greatest common divisor. The greatest common divisor, however, is not the only factor by which the excellence of a certain slot-ratio should be judged. It may be shown that a slot arrangement with a common divisor of a and an average number of slots n is not any better than an arrangement with a common divisor of $2a$ and an average number of slots of $2n$. The excellence of a given ratio of slots may be judged by a factor f, expressed as

$$f = \frac{a}{n}$$

where a is the greatest common divisor and n is the average of the number of stator and rotor slots. One may safely assume that a slot-ratio is better the smaller the value of f, all other conditions being unchanged. It is somewhat difficult, however, to decide what value f may be allowed to assume in order to obtain practical starting conditions. The admissible value of f depends upon a number of conditions. The value of f gives a measure for only the variation in the zig-zag leakage. The starting conditions depend, however, upon the variation of the total leakage; that is, the variation of the zig-zag leakage will have an effect which is smaller the smaller is the zig-zag leakage in terms of the total leakage. One may, therefore, say that the starting conditions are better the smaller the coefficient, F expressed as,

$$F = \frac{a}{n} \quad \frac{l_z}{l_t}$$

where l_z is the average value of the zig-zag leakage and l_t

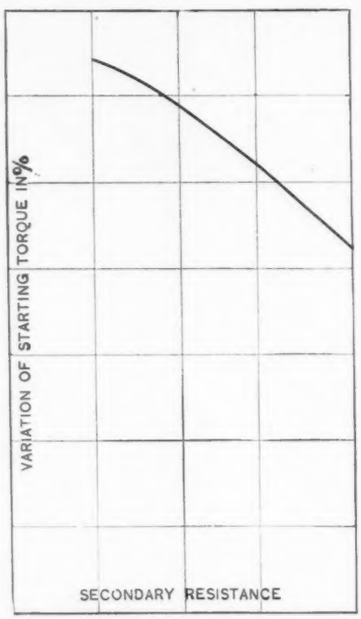


FIG. 1.—DECREASE IN THE PERCENTAGE VARIATION STARTING TORQUE WITH INCREASING ROTOR RESISTANCE.

is the average value of the total leakage. Since $l_z \div l_t$ is a ratio, it is immaterial whether the actual leakage flux, the leakage reactance, or the leakage coefficients are used for determining the ratio; it is essential merely that the same units be chosen for the two values of l_z and l_t.

In the case of motors with wide-open slots there is a chance for somewhat larger variations of the starting torque, and F should be kept smaller than for partially closed slots in order to insure equally good results.

It should not be inferred, however, that motors with a comparatively large value of F could not be satisfactory. If motors are designed liberally in regard to starting torque, it is quite admissible to allow some variation in the starting torque with change in the rotor position, and it is quite possible to obtain satisfactory results when F is comparatively large. It may also be shown that, with the same variation in the leakage, the per cent variation of the starting torque is larger with a small than with a large value of resistance in the secondary. For this reason F may be allowed to be larger for motors with high than with low secondary resistance.

Fig. 1 gives a curve showing the variation of the starting

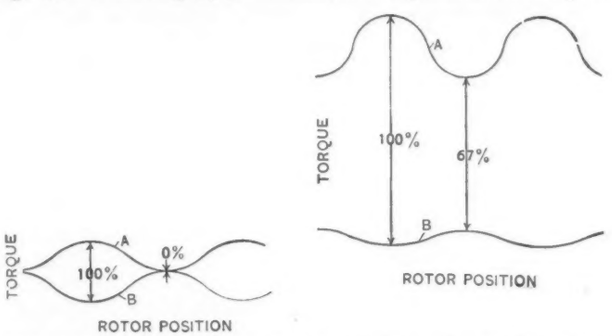
torque obtained for various secondary resistances of a squirrel-cage rotor, the same space variation of leakage being assumed in all cases.

In the case of coil-wound rotors, the variation of the belt leakage flux is of great practical importance, quite distinct from the phenomena discussed above. The variations of the belt leakage cannot be influenced greatly by a change in the ratio of the slots, and its discussion is, therefore, not within the scope of this article. It may be briefly mentioned, however, that one way by which the influence of the belt leakage can be reduced is to decrease the belt leakage itself to a minimum. This can be done by employing windings with fractional pitches which are as close as possible to 75 per cent of full-pitch for two-phase and 83 per cent of full-pitch for three-phase motors.

The belt leakage may also be reduced somewhat by increasing the number of slots per pole. Since motors with coil-wound rotors, however, are usually started with high resistance in the secondary circuit the variation of the starting torque is as a rule of no great practical importance.

Another factor which should be taken into consideration in connection with the starting torque is the friction in the bearings. The friction is equivalent to a counter torque which must be subtracted from the total torque exerted by the rotor in order to determine the value of the useful starting torque. While the friction torque is of no great practical importance in the majority of cases, it may be quite noticeable in cases where there is a strong unbalancing of the field around the air gap, and where, therefore, unbalanced magnetic stresses are possible. The variety of conditions under which such unbalanced stresses are responsible is very large, and depends upon the arrangements of the circuits, mechanical inaccuracies of the air gap, etc. In this article reference will be made to only such unbalanced flux conditions as are influenced by the ratio of the primary and secondary slots.

In motors with low-resistance secondaries the zig-zag leakage flux at starting is, as mentioned above, a considerable part



FIGS. 2 AND 3.—VARIATION OF THE STARTING TORQUE WITH CHANGE IN ROTOR POSITION.

of the total air-gap flux. Now the zig-zag flux will be weak at those parts of the circumference of the rotor where the rotor slots are situated about opposite to the stator slots; while the flux will be very strong where this is not the case. If it happens, therefore, that for certain or all rotor positions the leakage flux is strong on one side of the shaft while it is weak on the other, the shaft will be pulled to one side. In cases where the leakage does not vary very much with the change in the rotor position, the unbalance will cause a constant friction. In other cases where the leakage varies with the change in the rotor position, the unbalance may cause a varying friction, and therefore, a varying useful starting torque.

In order to avoid the unbalanced magnetic pull caused by unsymmetrically distributed leakage flux it is advisable to choose a ratio of slots by which the unbalance may be eliminated.

The fact that the friction torque is a factor which may be quite important in motors with low secondary resistance may easily be observed on motors with coil-wound rotors. In such motors, unbalanced pulls are frequently caused by mechanical inaccuracies of the air gap, and their effect can be easily observed, since the leakage flux and therefore the magnetic forces exerted by the same vary considerably with a change in the rotor position.

If the secondary is short-circuited the total torque of the rotor may vary by a certain percentage as shown by curve *A* of Fig. 2 on account of the leakage variation; moreover, the total torque is small on account of the low secondary resistance. The friction force (curve *B*, Fig. 2) may be comparatively large on account of the dissymmetry of the air gap, and may vary very much, since the varying leakage flux is the greater part of the air-gap flux. Furthermore, it happens that the friction is large where the total torque is small, and thus in extreme cases the useful starting torque may be zero for certain rotor positions; that is, the space variation in the starting torque may be 100 per cent.

If additional resistance be inserted in the secondary circuit of the same rotor, the total torque of the motor is increased, and the per cent of variation will be smaller. (See curve *A*, Fig. 3.) Under this condition the total air-gap flux is somewhat larger, and, therefore, the friction is increased somewhat. However, variations of the friction force are very much reduced, since the varying leakage flux now forms only a small part of the total air-gap flux. There is obtained a friction curve such as shown at *B* in Fig. 3, in which case the variation of the commercial starting torque is only about 33 per cent. The writer has observed such conditions very frequently in testing the torque of motors with and without additional resistance inserted in the secondary circuit.

While the cases in which the friction torque reduces the useful starting torque to zero are very exceptional in practice, there are many cases in which the friction torque is large enough to reduce the starting torque by an appreciable amount.

It is not claimed that the above outline gives a complete analysis of the "dead point" phenomena; nevertheless, the points brought out may be of interest.

Simplifying Some of the Calculations of Light.

BY CARL HERING.

One of the chief reasons why many of the calculations concerning light are generally considered difficult and vague, excepting the most simple ones, is the chaotic state of the present system of terms, measures and units which are involved. It reminds one of the vague and indefinite system used in electrical calculations prior to 30 years ago when a definite and uniform system was finally adopted and the units were properly named; since then the electrical science has been blessed with probably the best and most rational and the simplest system of measures and units of any branch of science or engineering, and this, no doubt, helped greatly in the rapid strides that were made. Our present system of measures and units of light hardly deserves to be called a system at all, as it is most unsystematic. The writer has examined the literature on the subject of the laws underlying the calculations of light, and finds that many writers are very vague in their expressions, and use such terms as intensity, quantity, brightness, illumination, flux, etc., in quite different senses, which is extremely confusing; in one case, for instance, in a well-known treatise of recognized standing, the same terms appear to be used with different meanings even on adjacent pages of the same book. There is one law which is well understood and easily used, namely, the law of the inverse square of the distance, and there is another concerning the quantity of flux from free point sources radiating in all directions like most lamps, which is being gradually understood better, but beyond these the measures, units and laws seem to be surrounded with a cloud of mist.

Physicists perform a valuable service to the practical engineer by discovering for him the laws of nature, but, unfortunately, they often present the results in such a form that they are useless for being applied directly to actual numerical cases in practice. If there was a rational well-established and clearly understood system of named units, it would not be so difficult to put

these physical formulas into forms in which they could be available in practice for numerical cases. Moreover, the application of these useful laws would be much better understood if we had a clearer physical conception of what these various quantities really mean, instead of simply calling them by indefinite names.

In what follows, the writer will not attempt to describe any complete and rational simplified system, nor to give a description of the true physical meanings of all the quantities, but will limit himself to one feature in the present system which has been the cause of much of the mistiness surrounding two of the quantities used in the measures of light. It will be shown that the confusion concerning the difference between these two measures and their units, and the difficulty in converting one into the other, arise from the fact that, although differently defined and named, they are really physically the same quantity and can, therefore, both be measured and expressed in terms of the same unit. Hence, only one unit is really required where there are now two; this will greatly simplify calculations concerning these two quantities and give a much clearer conception of their real physical meaning. To illustrate this remark with a simple analogy, in the ordinary system of measures use is made of two quantities or units called the cubic yard and the gallon. It is readily seen, however, that these two quantities are really physically the same, namely, volumes, or measures of space. When thus conceived, they are readily convertible into each other, and there is a fixed and definite relation between them. It may sometimes be more convenient to use the one, and sometimes the other, but if it is understood that they are identically the same kind of a quantity and that their only difference is a matter of convenience in the units, all mistiness concerning their apparent difference disappears. Two of the light units differ from each other in quite the same way, only their real identity, as a physical quantity or measure, is not quite as self-evident as it is with the two measures of volume.

These two quantities or measures are usually called "illumination" and "brightness of the source."

Illumination is popularly conceived to refer to light falling on a body, thereby illuminating it. More specifically, it is the amount of flux* of light passing through a unit of area, such as a square foot. That is to say, it is the flux divided by the cross-section, and is, therefore, in fact, the density of the flux or the flux per square foot; hence, it is quite analogous to current density, or to the flux density of a magnetic field. It does not express or measure any particular quantity of light flux, surface or intensity (in candle-power), but merely a flux density and nothing more; just as a specific gravity does not express any particular quantity of a material, but merely its density. The term "illumination" is, therefore, an unfortunate one, as it misleads and tends to limit the conception of the real quantity. It can be correctly applied to any part of a beam of light whether it falls upon a body or not; it is so used in the well-known inverse-square law; hence, it does not necessarily imply the existence of any body at all. A body properly placed receives this flux density and is illuminated by it, its illumination being measured in the same units as the flux density; this unit is here usually called the foot-candle and is the flux per square foot at 1 ft. from one candle. Such a body reflects more or less of the light, but what it reflects is, of course, also flux, and as this comes from a specific surface, it also has a flux density; if the reflection is perfect, the flux and the surface are both the same as formerly, hence the flux density will be the same, too; or if the body absorbs some light, then the flux density will be numerically less, but it will still be a flux density. Hence, what is called illumination applies also quite correctly to the light reflected from the surface; in fact, it must be so considered or else the calculations and measures of light become hopelessly mistified or obscured. All that a reflector does is to change the direction of light radiation, either regularly as a mirror or irregularly as a white card, but it gives back flux of light as such and this flux has a density determined by the surface, hence the reflected light has a flux density, which is the same kind of a quantity as illumination. It would be very desirable to distinguish between these two illuminations by distinctive names, but it should be remembered that they are both the same kind of quantities, such as the watts which go into an electric transformer and those which come out; they might be called "incident" and "reflected" illuminations, the difference between them being the absorption. When thus considered, there is no mysterious difference between the illumination falling on a wall and that reflected by it; both are correctly measurable in foot-candles; their difference is merely the loss by absorption.

The second quantity or measure referred to above is the so-called "brightness of the source." It is used in many text-books to refer to sources of light which are not really points; that is, to sources having an appreciable surface, hence a surface is involved in it as an essential part. It is generally conceived to represent the light-giving property of a unit of this surface of the source, such as a flame or the surface of a filament of an incandescent lamp, or the sun, etc. It was, therefore, generally measured in candle-powers from a unit area, and in this country the usually used unit is "candle-power per square inch." The unit adopted by the semi-official Geneva congress is the hefner unit per square centimeter. It was possible to measure the total perpendicular candle-power of a source and its surface; hence, by dividing one by the other, this quantity was expressed in terms of this unit. One is led to believe thereby that this is a quantity which is different from all the others; it is defined differently and is given a different unit. The other three quantities or measures, namely, intensity (candle-power), flux and illumination, are rigidly connected by formulas which enable one to calculate readily one from the other. If one attempts to combine this fourth quantity with these formulas, he finds himself almost hopelessly at sea. It does not fit in with them, it is not commensurate with the others, it is a stranger in a foreign land; if forced into this well-fitting group of formulas it breaks up their rigidity and leads to uncertain and mysterious results, or may even give totally wrong results; it greatly misleads the student. In the usual inverse square formula it can be used correctly under certain conditions (which are not usually stated), but for calculations of flux and of illumination under general conditions it gives absolutely wrong results.

A little thought will show that the cause of this is that it is an anomaly, a hybrid unit. Candle-power as a real physical quantity can be shown to involve, as a necessary part of it, a point—that is, something without dimensions. Its real physical meaning is a flux density defined in terms of a solid angle, which, like any other angle, involves a point as a beginning of the angle. It must be so considered or else it leads to physical monstrosities. To speak of the number of candles per square inch is like specifying the number of points there are on a square inch! When such a relation is introduced into a connected set of otherwise rational formulas, hopeless confusion must necessarily result.

The three fundamental formulas, reduced to common units, in which the lumen will here be used to represent the unit of flux, are:

$$\text{foot-candles} = \frac{\text{candles}}{\text{feet}^2}$$

$$\text{lumens} = \text{candles} \times \text{solid angle}$$

$$\text{foot-candles} = \frac{\text{lumens}}{\text{square feet}}$$

to combine which, it must be remembered that

$$\text{solid angle} = \frac{\text{square feet}}{\text{feet}^2}$$

This other unit, when referred to feet like the others, is

$$\frac{\text{candles}}{\text{square feet}}$$

If it be remembered that square feet and feet squared are entirely different physical quantities, one being a surface and the other a distance squared, it will be seen that nothing but physical absurdities arise by trying to combine this with the others.

The explanation of this is that the authors of this expression

*Flux of light means the quantity of light radiation, or the amount of such radiation, and is quite analogous to flux of magnetism or to flux or flow of electricity, more generally called a current of electricity.

"candles per square inch" have used the term candles too loosely and differently from its correct and more common use in the other formulas. There is no doubt that the candle-power and the surface of a flat source may be correctly measured, and that the one may be divided by the other to get a useful figure; the error is in assuming, as most persons naturally would, that this candle-power is physically the same thing as the candle-power of a point source, which latter is the basis of the usual formulas. One is thereby led to believe that he can substitute both of these candles in the same formulas, but this may lead to errors which are sometimes very large. A candle-power from a surface source (taken normally, as usual) is radically different in some important respects from a candle-power of a point source, namely, when calculating the distribution and the flux—for the same candle-power the flux of the latter is four times that of the former. Even the usual law that the illumination is inversely as the square of the distance is no longer correct under all conditions for the surface source, because the distribution is no longer even approximately uniform; it follows the so-called cosine law.

It can be shown that if S in the accompanying illustration is a small flat surface radiating light, and if SP represents the candle-power measured perpendicularly, then the polar diagram will be the small sphere A drawn on this as a diameter. In any other direction the candle-powers will be represented by the chords of this sphere, hence the distribution is very uneven and it is all in only one hemisphere. While if the source were a point having the same candle-power SP, its polar diagram would, of course, be the large sphere B. It can be shown that

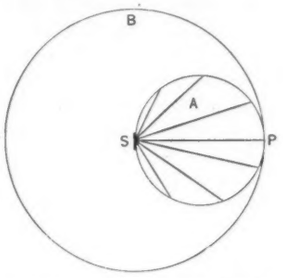


DIAGRAM OF LIGHT RADIATION.

the total flux from the flat source in lumens when given in terms of this maximum, normal candle-power, here called apparent candles, is numerically

$$\text{lumens} = \pi \times \text{apparent candles},$$

or in spherical candles it is

$$\text{flux in spherical candles} = \tfrac{1}{4} \times \text{apparent candles},$$

while for the point, radiating evenly in all directions, the flux is, as is well known,

$$\text{lumens} = 4\pi \times \text{candles},$$

or

$$\text{flux in spherical candles} = \text{candles}.$$

An analysis shows that the real physical meaning of candle-power, in its usual sense, is that it is a true measure of flux density, like illumination, but it gives this density in terms of the solid angle, while the illumination measure gives it in terms of a surface. It is sometimes more convenient to state the flux density with reference to the solid angle of a beam, hence in candle-powers, and sometimes in terms of a surface, hence in foot-candles; both units are useful and should be retained. Either can be converted into the other by means of the well known fundamental formula

$$\text{foot-candles} = \frac{\text{candles}}{\text{feet}^2}$$

In the sense in which the term candle-power is used in the measure, "candles per square inch," however, it can be shown that it really represents flux and not a flux density. In other words, the term "candles per square inch" has been used loosely for "flux (lumens) per square inch," that is, the authors of this expression have used the term candle-power to represent a quantity of flux, instead of a flux density, which the usual use of the term candle-power represents. It is, therefore, an unfortunate double meaning or use of the term candle-power which has caused the confusion. If the quantity flux, in lumens, be substituted for the quantity candle-power in the expression for this measure "candle per square inch," namely,

$$\frac{\text{candles}}{\text{square feet}}$$

(neglecting for the moment the numerical constants π and 144) there will be obtained,

$$\frac{\text{lumens}}{\text{square feet}}$$

This expression will be found to correspond, and to fit in, with the three fundamental formulas given above, and it at once clears up the mistiness surrounding the relations of this measure with the others.

It will be seen that flux divided by a surface is a true flux density which (unfortunately) is called "illumination," hence this unit of brightness is, in fact, really the same physical quantity as illumination. Both should, therefore, be interconvertible into one another like cubic feet and gallons are, and it is, therefore, not necessary to have a different unit for expressing and measuring it, especially so when the same term "candle-power" means something different in the two units, thereby giving rise to great confusion. All values stated in terms of "candles per square inch" can therefore now be stated just as correctly and much less ambiguously in foot-candles. It may be, and, in fact, is, convenient sometimes to refer to this quantity in terms of the candle-power equivalent of a surface source, or "apparent" candle-power, but it should not be used as a unit in a rational and rigid system of units and measures, owing to the ambiguous use of the term candle-power. To use always the same term with the same meaning, and only with that meaning, will greatly clarify the subject of the measure of light; the contrary has caused great confusion, mistiness, uncertainty and even great errors.

Before taking up the numerical equivalency of these two measures, it is well to illustrate their physical equivalency with an example. Imagine two surfaces next to each other, each having an area of 1 sq. in. Let one be melted platinum and let the other be a white matt surface illuminated from a hidden external source directly in front of it, so that the two surfaces would be indistinguishable from each other in their brightness, neglecting the possible color differences. The first is at present usually called a source and its so-called "brightness" is expressed by most writers in "candles per square inch," while the second is usually called an illuminated surface and is measured in foot-candles. Now if each of these is photometered normally they will both be found to have the same candle-power; if they are perfect surfaces they will both follow the cosine law in the distribution of the flux, and, therefore, the illumination produced at any definite angle will be the same in both; hence the flux also will be the same. They are, in fact, interchangeable in every way, as everything concerning the light given off by them is the same. It is inconsistent then to measure and express them differently and have different units for them, worst of all, incommensurate ones. There seems to be no good reason why the same units and measures should not be used for both, and as the foot-candle is a common, well-known unit which enters into the set of rigidly connected and well-known formulas, while the candle-power per square inch is an isolated unit, is less familiar to all, involves a different meaning of the term candle-power and fits in with none of the usual formulas, the choice naturally falls on the foot-candle. It is, therefore, quite proper and strictly correct to express and photometer all such flat sources of light, whether original sources or secondary, in terms of foot-candles or units of illumination so-called.

In regard to the numerical relations between the candles per square inch and the foot-candles it can be shown that an "illumination" of 1 foot-candle over 1 sq. ft. always represents 1 lumen of flux, no matter what its direction is, or whether it is directed light or diffused. If, for instance, 1 foot-candle on 1 sq. ft. were converted into watts of power, say, by complete absorption, it would always amount to the same number of watts. That is,

$$\text{lumens} = \text{foot-candles} \times \text{square feet}.$$

In other words, the total flux in lumens, say, from the walls

of a room, is the product of the illumination of the walls in foot-candles multiplied by their surface in square feet; the foot-candles may refer to the illumination which falls on the walls or to that which is reflected by them, the flux being then the corresponding one.

To find the normal candle-power which corresponds to 1 foot-candle from 1 sq. ft. it is necessary to determine the candle-power corresponding to 1 lumen when it is radiated from 1 sq. ft. in the same way as it is from white surfaces; that is, according to the cosine law. According to one of the above formulas for a small, flat surface

$$\text{lumens} = \pi \times \text{apparent candles},$$

in which the apparent candle-power is that measured normally. Hence this candle-power will be

$$\text{apparent candles} = 1/\pi \times \text{lumens},$$

or for 1 lumen over 1 sq. ft. of flat surface measured far enough off that this area may be considered very small,

$$\text{apparent candles} = 1/\pi = 0.3183 \text{ (or about } 1/3\text{) candle.}$$

This expression gives a numerical equivalent between candles and foot-candles under specific conditions, which value is often very useful. It simply means that if a white matt surface which reflects perfectly (that is, does not absorb any light) is illuminated to n foot-candles, then each square foot of it measured in a photometer normally to the surface, will correspond to $n \times 0.3183$ candle; that is, the light of a lamp of that candle-power placed where the surface was, will photometer the same or will illuminate a surface placed at the photometer screen to the same foot-candles. However, it must be distinctly understood that this equivalency extends no further, as it compares a point source with a flat surface source, which have different properties; the illumination in other directions and the flux will not be the same.

If now the number of "candles per square inch" be multiplied by 144 the corresponding candles per square foot will be obtained. But as seen above, a square foot illuminated to 1 foot-candle will photometer $1/\pi$ candles normally, hence

$$\text{foot-cand.} = \frac{\text{candles per sq. in.} \times 144}{1/\pi} = 452 \times \text{cand. per sq. in.}$$

This formula, therefore, enables one to calculate the foot-candles of any source whose brightness is given in candles per square inch, or the reverse; that is, it gives the conversion factor. This equivalency applies not only to candle-power, but to flux and distribution also, as it is a relation between two sources both of which are flat surfaces. If, for instance, the brightness of melted platinum is given as 120 candles per square inch, it is equivalent to $120 \times 452 = 54{,}240$ foot-candles. This means that if next to this square inch of melted platinum were placed a square inch of some perfect diffuse reflector, illuminated by a lamp of 54,240 candles 1 ft. distant, the two surfaces would be equally bright, would be indistinguishable from each other (except perhaps in color), would photometer the same candle-power, would give off the same amount of flux and would radiate that flux similarly (that is, they would have the same polar candle-power diagram); in short, they would be identical. Hence it seems much more direct and much simpler to express and photometer all such sources in foot-candles instead of in candle-powers per square inch.

The following figures* given originally in "intrinsic brilliancies in candle-power per square inch" have here been reduced to foot-candles:

BRIGHTNESS OF VARIOUS SOURCES STATED IN FOOT-CANDLES.

Sun in zenith			271,000,000
Arc lamp	4,500,000	to	45,000,000
Nernst glower			450,000
Incandescent electric lamp	90,000	to	136,000
Opalescent inner globe of enclosed arc	34,000	to	45,000
Acetylene flame	34,000	to	45,000
Welsbach lamp	9,040	to	11,300
Kerosene lamp	1,810	to	3,600
Candle	1,360	to	1,810
Gas flame	1,360	to	3,600
Incandescent (frosted)	900	to	2,260
Opal shaded lamps, etc	226	to	900

As was stated above, illumination may refer to the flux which falls onto a surface from a source, as when calculated by the well-known law by dividing the candle-power of the original source by the square of the distance in feet; in this case it is, of course, independent of whether the surface is white or black; or it may refer to the useful flux which is reflected; the difference is the absorption by that surface. Hence the above calculated value enables one to determine this absorption by a simple method. Illuminate a square foot of it with a known candle-power at a known distance and calculate the illumination in foot-candles which falls onto it; multiply this by 0.3183 (accurately $1/\pi$), which gives the value of the apparent candle-power if the reflection were theoretically perfect; photometer the actual candle-power of this square foot, and the difference between the two gives the loss by absorption. Conversely, if the absorption of the walls, ceilings, etc., of a room is known the approximate normal apparent candle-power represented by a square foot of them can be calculated if desired, knowing what the illumination which falls on them is. A test recently made by the Bureau of Standards showed the apparent candle-power of very perfect ground milk-glass to be 0.27 for 1 foot-candle on 1 sq. ft.; if theoretically perfect it should have been 0.31, hence the absorption was about 15 per cent.

Those of the above deductions which are based on the cosine law are, of course, subject to the inaccuracies of that law. In order to deduce correct relations it is necessary to assume the accuracies of the fundamental laws; allowance can then be made in the final numerical results for their inaccuracies due to the fact that actual surfaces and points are never theoretically exact surfaces and points. For instance, inaccuracies are always committed when any lamp is photometered because the law assumes the lamp to be a point, which is never the case; just so with the cosine law, which assumes perfect surfaces. Most of the calculations of the illuminating engineer, however, need not necessarily be exact. It would involve almost impossible calculations to make them so, and the results do not warrant great accuracy, as illuminations in practice need not be exact. In the average calculation of the illuminating engineer, therefore, it is more important to have some simple approximate formulas and rules which are easy to use than highly involved mathematical ones which would be more accurate.

*Art of Illumination. Bell. p. 9.

Propagation of Electric Waves in Wireless Telegraphy.

By James E. Ives, Ph.D.

It is proposed in this article to attempt to give a physical explanation of the throwing off of electrical energy into space by a wireless telegraph antenna.

The mathematical equations for electric waves, which were first given by Maxwell in 1864, indicate the possibility of a rhythmical propagation of electrical energy through space without the aid of wires. These equations, however, can hardly be said to describe, or explain, the method or mechanism of such propagation.

Hertz in 1888 showed experimentally that such electric waves actually exist, and that they behave in the same way as waves of light, moving in straight lines, being reflected, refracted and under proper conditions, interfering with one another.

In 1895 Marconi showed that long electric waves, carrying much energy, could be used for telegraphic purposes, and since his first experiments an army of investigators and experimenters have used these waves continuously for the purpose of long-distance communication. The result is that the earth is now dotted with wireless telegraph stations sending out and receiving these waves, day and night.

The belief in the existence of electric waves is now as strong and real as the belief in the waves of light, or even in the waves of the ocean. In the mind's eye, when a wireless telegraph station is in operation, there are seen ripples, in the all pervading medium, the ether, issuing from the antenna and spreading out in ever-enlarging circles, just as the ripples arise and spread on the surface of a pond from the point where a

stone has fallen into it. These electrical ripples in the ocean of the ether are the electric waves which carry messages even across the oceans.

Although this analogy of the water ripple gives an excellent idea of the sort of thing which is taking place around an antenna, when in action, and is therefore perfectly justified in its use, it does not explain in detail how these pulses of energy *become detached* from the antenna, nor does it explain how when once started they proceed to *move outward* from the

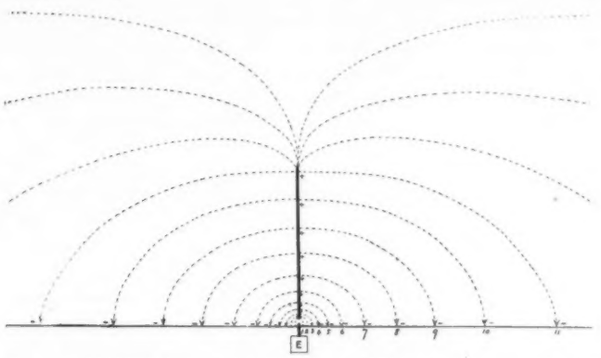


FIG. 1.—DISTRIBUTION OF LINES OF FORCE AROUND A CHARGED ANTENNA; THE CHARGES BEING AT REST.

source. It is the purpose of the present article to attempt to show how these two facts are the results of the properties of electric lines of force.

The diagram of Fig. 1 represents the electric lines of force passing from a charged vertical antenna wire to the earth. The charges on the antenna and on the earth are supposed to be at rest, and the conditions are such as would exist just before sparking takes place.

The heavy black vertical line represents the antenna wire; *E* is the earth plate; the heavy horizontal line, the surface of the earth; the dotted lines are the lines of force passing from the vertical antenna to the earth. For the sake of making the drawing more definite a positive charge is supposed to reside upon the antenna, and a negative charge upon the surface of the earth.

The approximate shape and distribution of the lines of force were found by assuming that the surface was a perfect conductor at zero potential. The equipotential lines were first drawn, freehand, around the straight antenna, and then the dotted lines of force were drawn at right angles to these equipotential lines, the number of lines of force drawn in any region being taken inversely proportional to the distance separating the equipotential lines in this region. When the charges are at rest, the lines of force must, of course, be at right angles

potential at any point due to the actual charges on the *antenna* and on the *earth*. The value of the potential being known, equipotential lines could be drawn, and the lines of force drawn at right angles to these equipotential lines in the manner already described.

Consider now what will happen if the difference of potential between the antenna and the earth becomes so great that a spark jumps from one to the other. The air in the spark-gap becomes conducting, so that, for a short time, the antenna and the earth form a continuous conductor. It is known, further, from the theory of the subject and also from experiment, that a standing electric wave is set up in the antenna having a potential node at the surface of the earth and a loop at the free end, and that the antenna becomes alternately charged with positive and negative electricity.

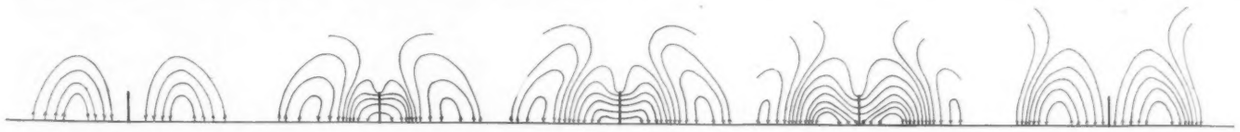
Suppose for the sake of example that the antenna is 100 ft.

Semi-loop breaking off. Semi-loop broken off; ¼ period later.

FIG. 3.—BENDING OF THE SEMI-LOOPS AFTER THEY HAVE ADVANCED A FEW WAVE-LENGTHS.

long, then the wave-length will be approximately 500 ft. and there will be approximately 2,000,000 alternations of the electric charge per second. That is, at one instant of time the antenna will be charged with a positive charge and 1/4,000,000 of a second later it will be charged with an equal negative charge. At the instant when it is charged positively there will be lines of force running from the positive charge on the antenna to the negative charge on the earth, as shown in Fig. 1. When the spark jumps from the antenna to the earth, the positive charge will run down the antenna into the earth, and the negative charge will, at least for a while, run toward the antenna from surrounding points. Some of it will run up into the antenna, so that after a very short interval of time—something less than 1/4,000,000 of a second in the case considered—the positive charge will have entirely disappeared from the antenna, which will have become *negatively* charged.

When the charges run together, what happens to the lines of force attached to these charges? Since lines of force can have no free ends, they must remain attached to the charges and move with them. In Fig. 1 the lines are numbered to facilitate discussion. Suppose, in order to make the ideas more definite, that there is a *unit* charge at each end of a line, positive at one end and negative at the other. The antenna shown in Fig. 1 would then have 14 positive units of charge upon it.



At beginning of an oscillation. At ⅛ of an oscillation. At 2/8 of an oscillation. At ⅜ of an oscillation. At ½ of an oscillation.

FIG. 2.—BREAKING OFF OF LINES OF FORCE AT DIFFERENT STAGES OF AN OSCILLATION.

to the antenna at the points where they leave it, and in like manner must be at right angles to the earth at the points where they end upon it. In most of the books on wireless telegraphy proper attention has not been paid to this point, and the figures are incorrectly drawn in this respect.

Absolute correctness has not been attempted in this drawing, but only approximate. A more correct figure could be drawn in the following manner: The value of the potential due to the charged straight antenna could be calculated by assuming that it was the only charged body in space. Then the value of the potential due to a similar antenna reflected in the earth but charged with electricity of opposite sign could be calculated. These two potentials added algebraically would give the actual

When the positive charge at the end of line No. 10 moves downward, the negative charge at the end of the same line moves inward; that is, toward the antenna. To understand what further happens to the line of force itself one must remember, *first*, that lines of force tend to shorten, and, *second*, that lines having the same direction repel each other. It is necessary also to introduce a *third* consideration; namely, the velocities with which the charges are moving on the surface of the earth and on the antenna, respectively.

Consider, now, the behavior of line No. 11 when the charges are in motion. Before sparking takes place, the unit of positive charge at the end of line 11 is about 100 ft. from the surface of the earth, and the unit negative charge at the other end of

the line is about 160 ft. from the foot of the antenna. When the spark jumps, the positive and negative charges move toward each other, according to the well-known law of attraction of unlike charges for each other; consequently the positive charge moves downward and the negative charge inward. When the positive charge has reached the lower end of the antenna, since the charge on the antenna may be assumed to be moving with the same velocity as the charge on the surface of the earth, the negative charge will still be 60 ft. from the foot of the antenna. Also, since the line of force due to charge No. 10, and all lines below it, will lie between line 11 and the surface of the earth, and since these lines repel each other, line 11 will form an arch, its two ends resting upon the surface of the earth. This arch is one-half of a loop. The other half of the loop, being the reflection of the arch, is in the ground. An instant after charge + 11 has reached the earth, charges + 12, + 13 and + 14 reach it. The lines of force attached to these charges are, at the time of reaching the earth, nearly vertical, and, since they have the same direction, repel each other. Charge + 11 with the line of force attached to it is therefore pushed away from the antenna, and the half loop formed by this line slides away from the antenna over the surface of the earth. This motion of the loop, having once been set up in the ether, will continue unless interrupted in some manner in virtue of that property of the ether which is analogous to mechanical inertia, and which, for short, may be called its inertia.

If instead of a straight antenna a linear oscillator had been made of two rods with a spark gap between them, in place of the arch, there would have been a loop, and this loop would have been broken off in the same manner owing to the repulsion exerted upon it by neighboring lines of force having the same direction.

After the antenna has emptied itself of the positive charge, in consequence of the electrical oscillation which is set up in it, it becomes negatively charged, and the lines of force reverse their direction. Each unit of negative charge entering the antenna has attached to it a line of force whose negative end is on the antenna and positive end on the earth. The positive end travels away from the antenna with the velocity of light and the negative end travels up the wire until the total charge on the antenna has reached its maximum value. It then reverses its motion and proceeds down the antenna until it reaches the earth. The line of force then forms an arch as before, but its direction is reversed. This arch, or semi-loop, becomes detached from the antenna in the manner already described, and slides away over the surface of the earth.

The successive stages of the above-described process are shown in Fig. 2, which represents the growth of the second half-wave.

The antenna having rid itself of all of its negative charge becomes again positively charged, and the process just described repeats itself, the antenna becoming positively and negatively charged until all of its electrical energy has been used up. The electrical energy of an antenna may be used up in three ways. First, it may be radiated off in the energy of electric waves; second, it may be converted into heat through the ohmic resistance of the wire; and third, it may be converted by induction into the energy of currents in neighboring conductors.

It is believed it will be evident from the preceding discussion that within a distance of about half a wave-length from a straight wire antenna there are no complete electric waves. Within this distance some of the lines of force are still attached to the antenna wire, and the complete group of arched lines of force, one inside the other, is not yet formed. Outside a radius of about half a wave length from the antenna, there exist these groups of arched lines of force one within another, each group occupying a space half a wave-length long on the surface of the ground. The groups move outward from the antenna, side by side, all lines moving with equal speed.

These moving groups of lines of force are indicated in Fig. 3. As is shown, they grow upward as they move outward, but do not long retain their symmetrical form. For after they have proceeded a short distance the tops of the arches bend backward, owing to the tendency of the energy to be propagated in all directions. This result may be explained on the assumption that parallel lines of force having the same direction repel each other.

Excellent pictures of moving loops of force are given in Fleming's "Electric Wave Telegraphy," Fig. 19, p. 347; and in Zenneck's "Elektromagnetische Schwingungen," Figs. 687 and 688. For the case of a linear oscillator the figures drawn by Hack and reproduced by Zenneck in the treatise referred to, Figs. 644-647, are particularly illuminating. These latter show what the figures given by Hertz and other writers do not; namely, the behavior of the lines of force within the zone immediately surrounding the antenna. Figs. 2 and 3 of this article are based upon the excellent diagrams of Hack.

High-Tension, Underground Cable Operation.

By Henry Floy.

In view of the many instances of successful operation of high-tension underground cables, the rather general prejudice against their installation appears to be unjustifiable. The use of aerial lines for transmission and distribution systems was logically to be expected in the early stages of electrical development on account of simplicity and low cost of construction. With the development of the industry and the necessity for putting wires under ground, insulated wires were introduced, which, like many other innovations, proved in some cases unreliable and unsatisfactory at the beginning; but with the development of improved processes and greater perfectedness in manufacture, underground cables, even for high voltages, have come to be regarded as reliable as almost any other appliance in the electrical art.

The lack of general information as to the improvements made in the manufacture of cables and as to the solution of the peculiar troubles likely to arise in the operation of high-tension cables, probably accounts in a large measure for the popular prejudice against their use. The only really valid objection against underground cables is their relatively high cost as compared with aerial lines, but this objection decreases in direct proportion to the increase in the number of circuits installed. Attempts to meet this objection of initial expense have been made in several ways, primarily and most successfully by substituting a cheaper material such as paper or cambric for rubber insulation; and secondarily, by the construction of cheaper forms of conduits in which the cables are drawn or by the abandonment of conduits altogether, simply laying the cables in the ground—as is being done at present, for example, by the New York Edison Company in city parks—or in some cases, where low potentials are used, embedding the bare conductor, in situ, in a cheap insulating material, usually a bitumen compound.

The practicability and reliability of cables for 110, 220, or even 500-volt service, is usually admitted; but when cables for higher potentials are considered it is often asserted that they are unreliable. Contradiction of such statements is best made by an examination of the records made by high-voltage underground systems, and the conclusion with regard thereto submitted by those having practical experience with such systems rather than by the consideration of statements of mere theorists or those not practically engaged in the transmission of electrical energy at high voltages underground, or those endeavoring to operate such systems who have not the education or experience qualifying them to do so successfully.

It is not perhaps generally appreciated that 26 years ago, underground cables laid in a trench filled with "Bitite," a vulcanized bitumen, were giving satisfactory service for low-voltage distribution in England, and that 25 years ago, Eastbourne, England, was lighted from the comparatively high-voltage circuits of the Brush Company which were contained in an underground system of iron pipes through which the conductors were drawn. Twenty years ago, 2000-volt underground

cables were in use in Rome, Tivoli, Turin and Milan, while Berlin early had a reputation for its underground system, and Paris began its sub-surface distribution by installing copper bars supported on porcelain knobs in its sewers. The well-known 10,000-volt concentric cables of Ferranti were installed in London over 18 years ago and early proved the success of high-tension underground transmission. In 1889, New York City had many miles of low-tension underground cables and the city authorities, resorting to police methods, were cutting down aerial lines to force the companies under ground. Since those days, marked advance has been made both in details of conduit construction and methods of cable manufacture.

To ascertain the present status of high-tension underground distribution, let us consider for a moment the expressed opinions of some of the well-known members of the engineering profession. Mr. L. A. Ferguson, president of the American Institue of Electrical Engineers and vice-president of the Commonwealth Edison Company, Chicago, which company has a station generating capacity of 120,000 kw and operates both aerial and conduit systems including nearly 300 miles of 9000 and 20,000-volt paper-insulated underground cable, in addition to much low-tension cable, succinctly states the superiority of sub-surface conductors over aerial construction as follows:[1]

"It is generally conceded that when the business will warrant the investment, electrical lines are much better underground than overhead."

An ex-president of the same society, Mr. H. G. Stott, chief engineer of the Interborough Rapid Transit Company—having 95,600-kw station capacity distributed wholly through 375 miles of 11,000-volt cables, some submarine—says:[2]

"I think it dwells in the minds of many able engineers that high-tension lines are very dangerous. I differ from that. I think the high-tension underground cable is the safest thing we have—a great deal safer than low-tension."

Mr. J. W. Lieb, Jr., also ex-president of the American Institute of Electrical Engineers and general manager of the New York Edison Company, which in addition to many miles of low-tension cable, is operating over 200 miles of 6600-volt cables—in referring to them has stated to the writer that

"There is no question as to the practicability and complete reliability of underground cables whether for low-tension or high-tension service, when compared with aerial conductors."

If we turn to the records of breakdowns on high-tension cables in actual use, we find the records substantiate the claim to reliability for high-tension cables.

Mr. Peter Junkersfeld, referring to the Chicago system, says their cable troubles[3] "during the last three years have averaged only two cases per 100 miles per year. This includes all troubles on 9000-volt cables from known or unknown causes, except those due to external injury to the lead sheaths." Of the total number of burn-outs, but a small percentage caused any serious shut-down, and the company is continuously extending its high-tension underground system.

The Interborough Rapid Transit Company, after several years of operation, found it averaged only one breakdown per year per 62½ miles of cable, including the larger number of interruptions liable to incur on new installations.[4]

The New York Edison Company has never had a complete shut-down of its system from any cause during the past 15 years, which, of course, includes its 200 miles of 6600-volt cable system. Despite the difficulties encountered in making installations in the streets of New York and the early period at which much of its underground system has been installed, this company has had only 66 cable breakdowns of all kinds during the nine years of operation. Of these breakdowns, 32 developed during operation and 34 were found either by periodic insulation tests or by inspections of the cables. Of the 32 that developed during operation only 18 were caused by other than mechanical injuries, which, based on 200 miles, makes a record of one breakdown per year per 100 miles of cable operated.[5]

Mr. Charles E. Phelps, chief engineer of the Electrical Commission of the City of Baltimore, Md., shows that the breakdowns of all the various cables—including telephone, fire and police service—amounting in 1906 to nearly 300 miles, operating in Baltimore under various potentials and as high as 13,000 volts, were 148 for a period covering seven years; or, omitting the years 1903-4-5, when the breakdowns were abnormally high owing to street improvements consequent upon the fire and electrolytic action, there is an average of about one breakdown per year per 10 miles of cable of all kinds.

In Buffalo, where for years they operated 11,000-volt cables and had a record of only two breakdowns, these from mechanical injury, from 1900 to 1906,[6] they were satisfied to double the voltage and are now operating at 20,000 to 22,000 with commercially satisfactory results.

In a paper read before the Pittsburg branch of the American Institute of Electrical Engineers, May 8, 1907, Mr. Charles W. Davis reported figures relating to operating breakdowns on 1,462,000 ft. of three-conductor lead-covered underground cable with potentials of from 11,000 to 16,000 volts installed on 14 different "construction jobs." The number of breakdowns of all kinds was 15, or one breakdown in joint for every 324 made; one breakdown in bends in manholes for every 340,000 ft. of cable, and one breakdown for every 227,000 ft. of cable lying wholly within ducts. Taking into consideration the four years covered by the breakdowns, there were from all causes whatsoever one breakdown per year per 227,000 ft. (43 miles) of cable. Mr. Davis concludes his paper with the statement that the figures indicate that "practically all the defects or faults existing in a system will be weeded out by the initial high-voltage tests, the remaining few, if such still exist, being developed by the first few months of regular service. This conclusion is confirmed by observations on many other installations not covered by these remarks."

Among the instances of less extensive installations than those referred to above, may be mentioned the Twin City Rapid Transit Company, of Minneapolis, Minn., which has, at present, some 60 miles of three-conductor, 13,000-volt paper-insulated cable, much of which has been operating since 1897, and during the last three years it has had a total of only six breakdowns due to other than mechanical injury or poor workmanship. Two three-conductor cables, one with paper insulation and the other with rubber insulation, were installed in St. Paul, Minn., in 1890, for 25,000-volt service and have been giving satisfactory results under rather exacting conditions. Although the first underground installation made for operating potentials anything like as high as 25,000 volts, at a time when there was considerably less knowledge and experience with high-tension work, these St. Paul cables have a total record of but 37 failures from all causes in nearly eight years of continuous service, and 33 per cent of all the failures occurred in one year, due mainly to special difficulties. The cables are connected to the end of a 24-mile aerial transmission line and are therefore particularly subject to lightning.

At Montreal, Canada, four three-conductor cables are operated, each about 4500 ft. long, at 25,000 volts. These cables were installed in 1902, and during the six years intervening to date only eight breakdowns in all have been reported, although for part of their length they are installed in ducts under a canal.

A second installation under the St. Lawrence River at Montreal, of three-conductor and single-conductor rubber insulated cables operating at 25,000 volts, part of which was made in 1906, and although connected by an aerial line and operating under water, only a total of one breakdown from all causes has been reported to date. The same company is also operating satisfactorily several 12,500-volt submarine cables. At York Haven, Pa., in 1906, were installed two three-conductor rubber insulated cables, each 3280 ft. in length, which have been operating continuously at 25,000 volts. These cables, between the generating

[1] Paper presented at the International Congress, St. Louis, 1904, entitled, "Underground Electrical Construction."
[2] *Transactions* A. I. E. E., vol. XXI, page 443.
[3] *Transactions* A. I. E. E., vol. XXVI, page 1614, Part II.
[4] *Transactions* A. I. E. E., vol. XXVI, page 1641, Part II.
[5] *Transactions* A. I. E. E., vol. XXVI, page 1617, Part II.
[6] *Transactions* A. I. E. E., vol. XXV, page 209.

station and one end of an aerial transmission line, are laid under water across the Susquehanna River. In Philadelphia, Baltimore and Jersey City, N. J., there are being operated a considerable number of miles of 13,000-volt underground cable. In New Orleans, where the ducts are more or less continuously filled with water, there are about 10 miles, and in Boston many miles, of 6600-volt cable. In Portland, Ore., a 11,000-volt submarine cable is operated. In New York City, the only railroads entering Manhattan are operated entirely therein by electricity supplied at 11,000 volts through three-conductor lead-covered cables that are partly submarine and partly underground, or in iron pipes; in the Borough of Queens, another railroad system depends for the operation of a large part of its service upon 11,000-volt underground cables.

Under the Hudson River at Poughkeepsie there are two three-conductor rubber cables operating at 12,000 volts, and at Houghton, Mich., similar submarine cables are operated at the same voltage. Across Great Bay at Portsmouth, N. H., there are two three-conductor rubber submarine cables, 5000 ft. in length, operating at 13,000 volts; and at Norfolk, Va., 4000 ft. of three-conductor submarine cable operating at 11,000 volts. In both Toronto and Quebec, Canada, 12,000-volt underground cables are in use. In Rio de Janeiro, Brazil, 13,000-volt cables have recently been installed, and nearly a year ago there were installed at Durham, England, over 60 miles of 20,000-volt, three-conductor cable, which, at last reports, was working successfully. The successful employment of high-tension cables under water or in ducts filled with water is particularly interesting, because of a popular belief that the use of high-tension cables under such conditions is almost impossible. Furthermore, such cables are often installed at the end or in the middle of a high-tension line, so that they are particularly subject to damage by lightning or the piling up of potential due to a change in the constants of the transmission line. Although the installations cited above refer only to constant potential circuits, it is well known that there are miles of underground series are circuits in most large American cities carrying potentials of from 6000 to 10,000 volts.

At the Louisiana Purchase Exposition at St. Louis, 1904, samples of cables designed for 50,000 volts (effective) and tested to 100,000 volts without perforation, were exhibited. Similar cable was shown at the Milan Exposition in 1906, which, being tested for breakdown point in about 15-ft. lengths, broke down at slightly above 200,000 volts.

The cable manufacturers in America and abroad are prepared to furnish what may fairly be termed high-tension cables. Some makers are prepared to supply and guarantee cable for 40,000 to 50,000-volt service, while one reliable manufacturer has submitted the writer a bona fide proposition for a client, to furnish single-conductor cables, lead-sheathed, for 75,000-volt service, pieces cut off to withstand a test of 150,000 volts, the price being comparable with that of a cable designed for more moderate voltages. One American manufacturer reports the production of a small amount of cable for commercial service, which satisfactorily withstood time tests of 150,000 volts and required about 300,000 volts to break down.

With regard to the cost of high-tension cables, the writer will refer to the matter more in detail in a subsequent article.

The installation and attempted successful operation of high-tension cables without intelligent and high-grade engineering supervision, especially at the time of installation, is liable to result in discredit both to the cable manufacturer and the operator. Systems which include high-tension cables are more liable, for example, to surges, oscillations or harmonics than those employing only aerial conductors, on account of the greater electrostatic capacity of the cables, so that, in all cases, proper devices for protecting against an abnormal increase of voltage should be installed. Devices such as static interrupters, electrolytic arresters, and other apparatus, have been developed which will effectively prevent damage from these troubles. Such protective devices, however, cannot be installed at random and without due consideration of the individual conditions under which they are expected to afford protection. An indiscriminate installation of protective apparatus which has proved successful in one installation, is by no means a guarantee that equally good protection will be secured in other installations.

Although underground cables require far less attention than aerial lines, periodic tests at higher than normal voltage, measurements of insulation and temperature, and inspection of conduits and manholes, should be made regularly.

CENTRAL STATION

MANAGEMENT, POLICIES AND COMMERCIAL METHODS

Electric Lighting Development in Chicago.

Few if any cities have seen a more extraordinary development in the use of electric energy for lamps and motors than Chicago. The facts are brought out very interestingly in the subjoined item from the *Electric City*, the admirable bulletin issued under the auspices of the Commonwealth Edison interests of Chicago. It says: "Chicago to-day furnishes the most complete and remarkable example of this electric energy distribution in bulk known to the world. Just recently authority was sought from a parliamentary committee of the English House of Lords by a great London corporation seeking to centralize the distribution of electricity in most of the territory comprised in London and its environs. The chairman of the committee before whom the promoters of the bill came was that very practical man of business and affairs, Lord Cromer, and associated with him the eminent financial authority, Welby, looking into the financial aspects of the project. In all the evidence submitted, that from Chicago carried the most weight and was listened to with most attention. It was the story of what has been done in Chicago, the vast territory served and the marvelous mileage of street and elevated railway supplied with electricity in bulk by central station power at a strikingly low figure. The London District Electricity Supply Corporation sought authority from the parliamentary committee of the House of Lords, before whom all such private bills must go, to duplicate Chicago's showing.

"And what did Chicago show? A central station enterprise giving complete electric lighting and industrial service over a minimum area of 200 square miles and reaching in part a maximum area of nearly 4500 square miles, for power is supplied to a point 85 miles north of the city, 50 miles south and 35 miles west. The greatest source of this supply shows one plant capable of carrying a peak load of 110,000 kw. One great and world-wide known commercial establishment takes a maximum load of 5000 kw from this central station. And in all, including 63 miles of underground railway, approximately 1250 miles, computing by the single track, of street and elevated railways are supplied with energy from the same source. The price of this electrical energy averages lower than the London corporation could offer. This is what Chicago has shown the greatest financiers and most practical business men in the world."

Electricity and the Fireless Cooker.

At the Michigan Electrical Association at Grand Rapids in August, Mr. John G. Gronberg called attention to the economy in cooking made possible by the use of the Swedish oven, in which cooking is done by stored heat. Notwithstanding the wide publicity given to this utensil by the late Edward Atkinson, who advocated the use of the fireless cooker as a matter of important national economy, and who invented an improved form known as "Aladdin's stove," which he dedicated to free use by the public, little headway has been made in this country with

this extremely economical device. The use in Europe has in recent years greatly extended beyond Sweden, and Mr. Gronberg stated that in Germany there are a score of factories making the utensil, one selling more than 50,000 last year.

As is well-known, the principle involved is preliminary heating of an article of food, which is then placed in a thoroughly-insulated receptacle and the cooking slowly proceeds from the stored heat. The primitive hay-box form will keep the temperature above 160 deg. for two hours, while the type usually found on the market extends this time to eight hours or more. In the more improved forms cloth and felt insulation are displaced by vulcanized wood, asbestos and other materials of a durable, sanitary nature, and the utensil adapted to baking and roasting. In the latter case the heater is stored in steatite radiators or slabs, which quickly absorb heat. The radiators are heated over flame or by electricity. That it is possible to use electricity in connection with the fireless cooker with proportionately greater economy in the use of fuel than in the use of gas, oil or coal, has, it is stated, been practically demonstrated in the fireless cookers ready for the market. The reason why the economy is greater with electricity is that it is possible to utilize practically all of the heat generated by the current. The coils are introduced in the radiators, and while the temperature is being raised the oven is closed to prevent loss of heat. Mr. Gronberg predicts that the combination of the fireless cooker with electricity will do more than any other agent to bring electric cooking into every-day, common use. If it is possible to cut off three-fourths of the present cost, electric cooking will be multiplied many times.

Discussion on Chicago's Water Power.

At the Wednesday noon meeting of the Chicago Electric Club, on Sept. 9, Mr. W. D. Ray, contract agent of the sanitary district of Chicago, electrical department, gave a short talk on the marketing of the electric energy created by the Chicago Drainage Canal. The sanitary district of Chicago has at Lockport, the present terminus of the canal, a plant which can deliver 20,000 kw with the present flow of the stream. With additional stream flow it is expected to increase this finally to 40,000 kw. The sanitary district has invested about $50,000,000 in this canal and about $3,000,000 more in the electric plant to utilize the by-product energy which is created by the drainage canal.

Of the possible present output, about one-third is now used by the city of Chicago for lighting at night. Considerable output can yet be sold. Mr. Ray estimated that the drainage canal energy will amount to only about one-tenth the total electric energy required for all purposes in the city. In two years' time it is expected that the district will have a revenue of $2,000 per day from the sale of electric energy. This energy is sold to municipalities within the sanitary district at a rate near cost, since the citizens of these municipalities have been taxed to build the drainage canal.

The rate to the municipalities for lighting and power purposes is $15 per horse-power per annum, delivered at the substation in the outskirts of Chicago where the high-tension transmission line terminates. This is for electrical energy used 12 hours per day. For service 24 hours per day the rate is $26.40. This charge is based on the maximum demand taken as the average of the three maximum peaks in any month. In marketing energy for industrial purposes to private consumers in Chicago, the rate is 9 cents for the first 30 hours' use of the maximum demand; 4 cents for the next 30 hours' use, and 2.5 cents for the remainder. Mr. Ray said these rates are from 20 to 30 per cent below those of private concerns selling energy in Chicago, the distribution being confined at present to manufacturing districts along the railroads where large contracts can be obtained. Up to date the sanitary district has spent about $75,000 in building distributing lines. He stated that it is the policy of the district to build distributing lines only in the more profitable places and not to cover the city with a distributing network.

Mr. J. R. Cravath, in the discussion which followed, urged the extension of the city's electric lighting system and the use of the energy for additional city pumping, in order that the public might get the most benefit from it. He thought that public interests would be better served in this way than by marketing energy to private consumers with a poor load factor, who use their maximum demand for only a few hours per day.

A Davenport, Iowa, Advertisement.

The accompanying reproduction is an example of a kind of advertising being employed by the People's Light Company,

THE MODERN WAY
IRONING DAY OR ANY OTHER DAY
The old method of having to start a coal fire to heat an iron for ironing out a few handkerchiefs or a wrinkled shirt, is still adhered to in many Davenport homes. The new method of attaching an electric cord to an electric light socket, then using the ELECTRIC IRON, is so convenient and inexpensive that it is fast taking the place of the old methods.
The Electric Iron can be used anywhere in the home—Kitchen, Sewing Room, Dining Room, Laundry, any place where there is an Electric Light. The cost of the Iron is only $4, delivered to your home, with cord, all ready to use.
We wire houses for Electricity at cost This is a good time to have your home wired. Call 97 or see our salesman.

A DAVENPORT ADVERTISEMENT.

of Davenport, Iowa. The illustration is very much reduced, the advertisement occupying a quarter-page in the *Daily Times* of that city.

Motor-Driven Compressors for Rock Drills.

A visit to towns in the Lake Superior region recently, where rock drills are in abundance not only for quarrying, but for grading of streets, etc., showed that motor-driven air compressors for supplying these pneumatic rock drills are displacing steam plants. Electricity can usually be supplied by central stations for this purpose at a rate which will make it uneconomical to operate a steam plant. In the cases where the steam direct from the boiler is supplied to operate the rock drills, the trouble from freezing in the winter and the trouble with steam hose make the motor-driven compressor desirable. Mr. William Chandler, in a discussion at the Michigan Electric Association in August, spoke of a 225-hp motor driving a compressor supplying rock drills at Sault Ste. Marie. This compressor plant made a saving of $7,000 in first cost over that of the former steam plant, which would otherwise have been erected by the contractor. Contractors are also finding motor-

driven centrifugal pumps useful in cases where ditches or excavations must be drained. Sometimes these are equipped with automatic float-operated starting devices, that an excavation may be kept drained at all times, the motor starting whenever water in the sump from which the suction is taken falls below a certain level.

Gas Competition.

The advertisement reproduced herewith is one of a series which the Boston Consolidated Gas Company is using in an aggressive newspaper campaign which it has recently begun. The advertisements, which occupy a generous space, appear in all of the leading Boston papers. It is rare for a gas company to be thus aggressive in print toward electrical competi-

Important Maxim

One of the most IMPORTANT MAXIMS of ILLUMINATING ENGINEERING, or the study of SCIENTIFIC LIGHTING, is that the LARGER the SURFACE which GIVES THE LIGHT, the BETTER for illuminating purposes.

Gas More Effective

This is ONE OF THE REASONS that the light given by the GAS MANTLE is so much more EFFECTIVE than that of the ELECTRIC LAMP.

Compare the SURFACE of the GAS MANTLE with that of the INCANDESCENT FILAMENT in the electric lamp, and the reason for the SUPERIORITY of the GAS LIGHT is READILY APPARENT.

Objectionable Shadows

You are all familiar with the DISAGREEABLE SHADOWS given by the ELECTRIC ARC for street lighting. This SAME UNEVENNESS in the light is UNAVOIDABLE when ELECTRIC LAMPS are used INDOORS. This effect is NECESSARILY CHARACTERISTIC of ALL electric lamps, and is due to the SMALL LIGHT GIVING surface which they have.

Gas Ideal Illuminant

This is in MARKED CONTRAST to the RESULTS OBTAINED with the GAS MANTLE. The ABSENCE OF SHARP SHADOWS, the DIFFUSION and EVENNESS of the light, all combine to meet the principles of IDEAL ILLUMINATION and give a VERY SOFT and PLEASING EFFECT.

New Gas Lamps

To satisfy the BEST PRINCIPLES of SCIENTIFIC LIGHTING we have gotten out some NEW TYPES of GAS LAMPS, including IMPROVED FORMS of the INVERTED LAMP, which are a DIRECT RESULT of the INVESTIGATION of our EXPERTS IN EUROPE, who returned last July.

BOSTON GAS ADVERTISEMENT.

tion and still more rare for such a company to base arguments against the electric light on the principles of illuminating engineering. Doubtless the advent of the tungsten lamp is largely or entirely responsible for the new program, as the former reliance on the argument of cheaper cost of gas illumination has ceased to be tenable.

Central Station Situation in Lima, Ohio.

A fight over an electric lighting situation at Lima, Ohio, has been carried into the courts. A special meeting of the City Council was recently called to reconsider an ordinance providing for the erection of a municipal plant, but the friends of municipal ownership secured a temporary restraining order to prevent the Council from reconsidering the ordinance. The order was delivered while the body was in session and friends of the proposed ordinance claim that if the members had not indulged in speech-making instead of getting the ordinance before the house it would have passed before the injunction was served.

Bonds have been sold for the erection of the new plant and the money is in the city treasury, but quite a large percentage of the people is opposed to the ownership of a plant by the city. Nothing can be done now until the courts pass upon the matter. The present lighting plant has made a hard fight to retain its business in Lima, even offering to do the lighting at a figure that allowed very little margin.

Electric Signs and Flat Irons.

At the Put-in-Bay convention of the Ohio Electric Light Association there were presented two papers devoted to electric signs and other special users of energy as adjuncts to profitable consuming devices for central station load, the authors being Mr. C. A. Elliott and Mr. H. Engle.

Mr. Elliott stated that electric signs and display lighting, besides having excellent advertising qualities for the merchant and affording good business for the lighting company, are added assets to the city, as they increase its commercial standing materially. They also have an inestimable value to the lighting company, as they instill the electric idea into the minds of the people on the street at night.

Electric outlining by means of low candle-power lamps is the foundation of all decorative and display lighting which is almost a necessity to the up-to-date merchant, as it offers the best opportunity for an attractive and distinctive frontage, which is essential in these days of keen competition. Outlining can be done with either 2-cp or 4-cp lamps spaced on from 10-in. to 18-in. centers, following the lines of the building, the floors and windows.

The electric sign, with which the merchant places his name and goods before the public, cannot be equaled from an advertising standpoint. The flashing sign is even more attractive than those steadily illuminated, and those showing motion, which are the latest development of the flashing type, are particularly attractive. Window lighting should not be overlooked as the base of advertising from the merchant's standpoint, as it is the means of displaying his goods.

All decorative and display lighting should be controlled by the lighting company on an "off-the-peak" schedule. The hours of use is what determines the desirability of the business and should receive very careful attention; therefore, if turned on at 5:30 p. m. during the winter months and at dusk during the summer months and used until 11 or 12 o'clock each and every night, decorative lamps will in most cases be worthy of a low rate, as they materially increase the load factor of the station, thereby reducing the cost per kw-hour generated. A flat rate should be charged for such service, as this appeals to the merchant and would come under the head of fixed expenditures for the month. The monthly charge would be based on a stipulated rate per lamp per year, say $2 for 4-cp lamps and $1.40 for 2-cp lamps. This arrangement allows about a 6-cent rate for energy, together with switching charges and one-half the lamp cost, and affords a very flexible and satisfactory rate.

Window lighting should be handled along practically the same lines as flat-rate lighting. It may be found desirable for the merchant to have the privilege of turning on the lamps earlier than the sign schedule, the lamps to be turned off by the regular sign man employed by the lighting company. A meter rate of from 6 cents to 7 cents net per kw-hour can be charged for such service.

Mr. Engle said that there are four excellent reasons why electric signs should be advocated by central stations, namely, the station receives the maximum amount for exterior lighting without lowering the revenue from inside lighting; the user improves his business by the use of devices supplied by the station and therefore he is a satisfied customer; the signs serve to advertise the central stations actively, and the successful operation of an electric sign will assist in inducing the customer to install other devices consuming electrical energy.

Mr. Engle claimed that considerable success had rewarded

the efforts of the Youngstown Consolidated Gas & Electric Company in introducing electric flatirons. Three means have been used for bringing the irons to the attention of prospective users, the newspapers, house-to-house canvass and the telephone. The house-to-house canvass has been the most effective. The irons are distributed for a 30-day free trial. All heating units burned out are replaced free of charge. Irons have proved excellent devices for permitting the central station men to come into personal contact with the customers.

Electric Heating in Michigan.

At the Grand Rapids convention of the Michigan Electric Association a committee consisting of Messrs. William Constable, R. W. Hemphill, Jr., and H. A. Mott gave the result of a canvass of Michigan central stations on the subject of electric heating. Returns were received from about 30 central stations, which reported that in spite of the hard times during the past nine months the call for heating devices kept up in a most gratifying manner. Most of the stations kept up interest in this field through display rooms, window displays, demonstrations, advertising and free trial offers covering a week to a month on many of the most popular devices. While most of the devices have not had any phenomenal sale, the flatiron has more than held its own, over 4000 irons having been sold in the State since last October. It is estimated that the number of electric irons in use in the State is 20,000, representing a heating income without increase in investment of plants or transformers, of about $100,000 per annum, with still 60 per cent of the residence customers to work on; hard work and the co-operation of manufacturers in giving a still more perfect iron should raise the annual income to $150,000 the coming year.

Troubles from burn-outs and other mechanical defects of several years ago have been almost entirely eliminated. The most serious of present troubles is with the cord and plug attachments. The manufacturers have spent considerable time and energy in trying to remedy these troubles and have made excellent headway. As to the best methods of pushing the sale of irons, the committee finds a uniform policy among most of the Michigan companies, namely, a house-to-house canvass, accompanied by frequent demonstrations in show windows, fairs, etc., along with generous advertising, both by printed circular and in the newspapers. A free trial offer of from one week to 30 days' use has brought more gratifying results than any other method. Some of the smaller stations report only 10 per cent of the irons put out in this way returned, while with the larger companies it runs as high as 40 per cent. Another way that has been found successful is to send, unsolicited, an iron with every new residence meter, as part of the installation. In this way every new residence customer has a chance to try the electric iron.

Next to the flatiron in popularity and as income earners are the toaster, water heaters and luminous radiators. Most stations report the toaster and luminous radiator as equal in popularity, some of the stations having as high as 150 of each on their lines, while others report no call whatever. The sale of chafing dishes, percolators, heating pads and other devices seems to be limited, either by reason of their first cost or else infrequency of use. They are, undoubtedly, a fine advertising medium, but at present are not worthy of the same consideration and development as the flatiron.

Another field which seems for some reason to have been left undeveloped is that of commercial heating, namely, glue pots, solder pots, soldering irons, branding irons, etc. Perhaps one of the greatest drawbacks to the introduction of these devices is the high initial cost and frequent burn-outs which are reported, particularly on soldering irons. Very few of the stations report any great advances in the introduction of cooking outfits. The initial cost of the outfits and devices seems to be one of the greatest drawbacks. Even with such a rate inducement as 2½ cents per kw-hour, as established at the Soo, they do not report any great amount of business from this line.

Another of the drawbacks to the present electric cooking outfit is its limited reserve capacity for the average family, and also the inability of any yet known devices to heat enough water for the average household at anywhere near a reasonable price. The committee thinks that before the electric cooking outfit is a success it is necessary to furnish the public devices that are not only fool-proof, but more efficient, longer lived and of lower initial cost. Tests have shown considerable saving by the use of the fireless cooker in connection with electric outfits, and many of the stations are already recommending its use.

Increasing Central Station Business.

An interesting paper on methods of increasing central-station business was read by Mr. F. H. Plaice at the Put-in-Bay convention of the Ohio Electric Light Association. The author said that the electricity salesman, then, must be an enthusiast, a dreamer, an engineer, an artist, a machinist, a tactician and an all-around student of human nature. He must be able to keep his temper under any and all conditions, must actually know what he is talking about, and must have the tenacity of the bulldog developed to the highest possible point. His faith in himself and his wares must be so overpowering that the prospective customer will be dragged into synchronism in spite of himself.

To go to a large manufacturer, who, for a lifetime, has successfully operated his factory by means of a faithful steam engine, and convince him that that faithful servant should be thrown to one side, and that an almost unknown motive power should be substituted for the well-known, at a prospective cost of perhaps several thousand dollars, all because of the saving of a fraction of a cent per hp-hour which is promised him, but of which the manufacturer knows nothing, certainly requires the very highest grade of enthusiasm and sanguine faith.

Electrical companies have three great fields in which their product is naturally supreme, and it remains to properly educate the public in order to get that to which they are entitled. First, there is the artificial lighting field; second, the field of mechanical work; and, third, that great, but as yet almost untouched, field of heating.

The educational phase is probably the most important of any of the many conditions surrounding the extended sale of electricity, and the one that should be studied the closest. Few customers know that a sewing machine can be run by a tiny motor, which will use less electricity than the better known 16-cp lamp; or, that the special nightmare of the good housewife—washing day—can be driven to the realms of oblivion by means of electricity and a small motor, at a cost of only a few cents per hour. At least one-half of the customers of all the companies represented in the association have yet to learn that there is such a thing as an electric flat iron, and probably another one-fourth do not know what the electric flat iron looks like. Education, then, must be fostered. The public is quick to avail itself of such meager opportunities as it usually gets and, like other willing students, learns rapidly.

There are many different means of educating, such as outline lighting campaigns, sign campaigns, electric shows, summer park lighting, demonstration displays; canvassing, advertising, signs, bulletins, circulars, etc.

In making an energetic endeavor to obtain new business a company will find that its growth will be faster than the public at large is able to grasp, and it will become necessary to do a great deal of demonstrating. It must stand ready at all times to make a dollar-and-cents proposition on the probable cost of a certain service and then guarantee it.

A prospective customer should not be told that a 16-cp lamp will use so many watt-hours in such and such a time; he may ask you what a watt looks like—but talk to him in the more familiar language of dollars and cents.

When a motor proposition is encountered, the case requires a thorough knowledge of the power requirements of the different classes of machinery and general motor usages, but it is, in

other ways, not a difficult problem to answer the inevitable query: "How much will it cost?"

A central station must advertise, but advertising does not necessarily imply a contract for a certain amount of space in each issue of the home papers. Far from it, for, outside of its possible good effects on the publishers themselves, it does not pay very big returns on the investment. It is admitted that a limited amount of money spent in newspaper advertising is necessary and desirable, in order that the papers may take an interest in the work of the station, but to expect large returns from newspaper advertising is to be disappointed. The same amount spent in demonstrations will show far larger returns.

Fans, irons, lamps, motors, large and small, or any other appliances that will become a consumer of electricity in service, should be placed on trial. Ninety-five times out of a hundred the device will be retained; the expenses of the five failures should be counted as that much advertising.

The same idea should be carried into all lines of work. For instance, a church or other organization may be giving an entertainment and want some form of special service. It is good business policy to take advantage of all such opportunities to advertise the central-station product. This form of advertising is rather expensive, but the cost is made up mostly of labor and the returns are amply remunerative to justify the outlay.

Experiences with Electric Heating at Sault Ste. Marie.

At the convention of the Michigan Electrical Association at Grand Rapids, Aug. 18 to 20, considerable attention was given to the subject of electric heating and cooking as a source of central-station revenue. Messrs. William Chandler and D. B. South, of the Edison Sault Electric Company, presented a paper on "Electric Heating in Sault Ste. Marie," telling what that company has done and the outlook for this kind of work, as it appears to the authors.

The Edison Sault Electric Company organized an electric-heating department and opened a fine display room in April, 1907. This was supplemented with generous advertising and with the announcement that a special rate of 2.5 cents per kw-hour would be made on this class of business. The display room was stocked with $2,000 worth of the principal heating and cooking devices on the market. This department is being still maintained, although the success in securing satisfactory returns from the outlay has not been up to expectations.

For the period of 13 months ending Jan. 1, 1908, the company expended a trifle in excess of 3 per cent of its gross income in soliciting electric heating business and advertising. While in many respects the experiment has not proved a phenomenal success, the authors believe in its future and propose to continue to advocate electric heating and cooking as a means of public education. Being told that the greatest obstacle to the universal adoption of electric heating was the excessive cost for current, the company decided after some deliberation to make a rate of 2.5 cents per kw-hour, believing that 80 per cent of all the power demand created would not be during peak-load hours and would help make up profitable day business. With this rate electricity for heating purposes is at par with gas at $1 per 1000 cu. ft.

The company has discovered that it is not the cost of operating the apparatus that holds back the business, but rather the initial cost of the heating devices and their installation with the necessary special wiring. Where an electric-cooking installation complete for an average family costs not less than $100, including the necessary special wiring, and the householder already has in the neighborhood of $75 invested in the regulation coal range, it will take much work along educational lines to convince him that it will be wise to abandon his coal range and appurtenances and purchase an electric-cooking outfit with which, in the present stage of development, he cannot do all his cooking all the time.

The authors expressed great confidence in what a few years will bring forth, and believe that the future will show electric heating as one of the principal sources of central-station revenue, but just now it is in its swaddling clothes. One essential will be an electric range that will not only accommodate the average family, but will have some reserve capacity and will also take care of the water-heating problem. The lack of a device for properly heating water in quantities sufficient for household use has caused many prospective investors to abandon the idea of making an installation for heating and cooking purposes. The authors found that their Sault prospect is a discerning fellow. He will wait until greater progress has been made in the manufacture of such articles, and he says they must cease to be an experiment before he will spend much money on them.

About the most profitable heating device on the market now, as has been the case for a number of years, is the old reliable flatiron. Irons in certain localities will average 6 kw-hours per month the year round. The Edison Sault Company is receiving approximately $3,300 per year of very desirable business from irons with no increase of investment in plant or transformer account. The investment is made by the customer. Any plant not now having a 24-hour schedule could afford to operate one day in the week by securing the available flatiron business in its town. The most serious defect of the iron which this company has handled is in the deterioration of the plug and cord where connection is made to the iron. Renewals and repairs of these have been made free. These parts have recently been much improved. The writers do not believe that the plug should be detachable from the iron. Seventy per cent of the company's residence customers are using electric flatirons. Next to the flatiron they have found disk stoves and luminous radiators to be the most popular with customers.

In the display room a wattmeter is connected to the various cooking devices displayed. On the right-hand dial of the meter is a large cardboard dial graduated to one-eighth cent, making a total of 2.5 cents per kw-hour for a complete revolution of the pointer on this dial, showing prospective customers what the devices will cost to operate. This had the effect of inducing a number of refractory customers to learn to read their lighting meters and check their lighting bills, which is a good thing for the company and for them.

INTERIOR WIRING AND ILLUMINATION

The Wiring of Old Buildings.

Strange as it may seem, the wiring of old buildings for the use of electricity is not attended with the muss and damage incident to the installation of gas pipe, for instance, or of plumbing work. In frame houses it is possible to install a complete job of wiring with flexible armored cable without cutting the walls at all except where outlets and switches are to be installed, and usually where care is exercised these can be inserted in the walls without damage to the decorations or plaster work. In brick dwellings, especially where party walls are encountered, it is necessary to cut chases in the party wall, 1 in. or 2 in. wide, depending on the number of circuits to be installed, if outlets are desired on the party wall; but in all other cases the flexible armored cable may be run between the studding of partitions, above the lath in the ceiling, between floor joists, across notches cut in the floor joists or back of the lath on front, rear and side walls where furring is used between the wall and the lath. The furring on front and rear walls varies in thickness from 2 in. to seven-eighths of an inch, and the furring in side walls is usually seven-eighths of an inch thick. The outside diameter of twin No. 14 wire, flexible armored cable is approximately seven-sixteenths of an inch so that it will readily pass back of the lath of ceiling and walls that have been furred.

In brick or other dwellings where decorations are to be made

after the wiring work is completed, it is usual in the interests of economy to avoid circuitous routes from outlet to outlet and to cut chases in a direct line if possible, the woodwork, of course, being spared. It is very much cheaper in cases of this kind to cut and patch than to spend material, time and labor in running a long circuit in order to avoid any cutting. Where a house is already decorated care must be exercised to avoid damaging the decorations, but where a house is to be redecorated the most expeditious method of installing the wires is the best, it being taken for granted, of course, that any wireman will use reasonable care and judgment and not make unnecessary muss or cause damage.

The accompanying illustrations show an eight-circuit job in a four-story brick dwelling. Flexible armored cable was used and the interior was to be redecorated so that the extra care which would be bestowed on a building already decorated was not exercised. The illustrations, however, cover an ordinary job of this kind, and in some instances the plasterer added to the size of the chases, etc., in preparing the rough edges for his work, and the chase cut in the wall near the ceiling, in Fig. 5, was made by a gas fitter in running down the short length of pipe shown for a drop lamp and not by the electrician.

The panel box is located on the second floor in a hall closet, as shown in Fig. 1. The box is built in sections, each section holding two cut-out blocks. One-inch flexible conduit is run from the meter board in the cellar to the bottom of the panel box, the conduit being shown stuffed to keep out foreign matter. Four circuits run from each side of the panel box; one for the top floor, one for the third floor, two for the second floor, two for the first floor, one for the basement and cellar, and one for the night or hall lamps. The standard connector with lock-nut is used to fasten the armored cable to the panel box and about

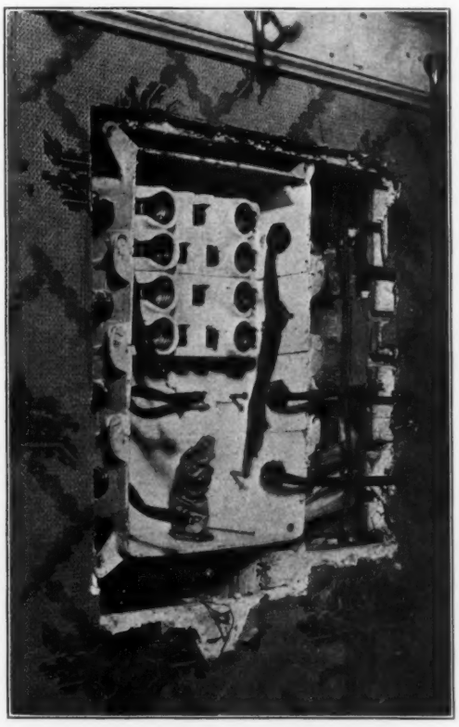


FIG. 1.—PANEL BOX IN HALL CLOSET.

8 in. of wire is left free for making connections. The conduit is grounded.

Figs. 2 and 3 are views taken in the parlor on the first floor. In this room there are four wall outlets and a switch, besides two chandeliers. There is a high baseboard along the bottom of the wall and a cornice at the ceiling, which it was desirable not to cut. The illustrations show the same side of the room next a party wall. The switch controlling the circuit is near the outlet on the hall partition wall and the circuit runs from the switch to the first outlet and then down to the floor. Passing under the floor joists the flexible cable is run above the lath to a point under the second outlet on the hall partition wall near the front of the house. From here the circuit passes up between the studding to the outlet and down again, crossing the floor between joists and thence up back of the lath on the front wall to a point about level with the outlet, whose position is fixed by a gas connection. From this point to the outlet a 2-in. chase

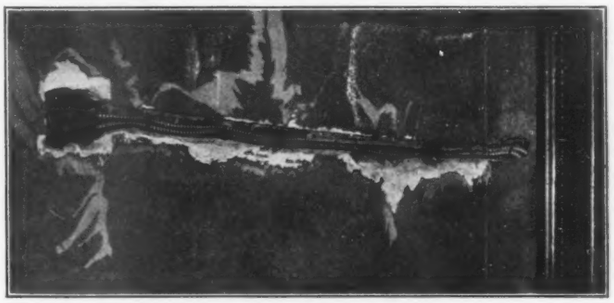


FIG. 2.—CHASE IN PARTY WALL.

is cut in the plaster and brickwork to accommodate the cable, as shown in Fig. 2. From this outlet the circuit returns to the front wall and passing down runs under the floor joists to the partition wall between the rooms. The cable is run up between the studding and is brought out to outlet shown in Fig. 3 through a 1-in. chase cut in the wall. The circuit ends at this outlet. It should be pointed out here that in all work of this kind it is usual to end the circuit on brick walls, if possible, so as to avoid excessive cutting as much as possible. As will be noticed,

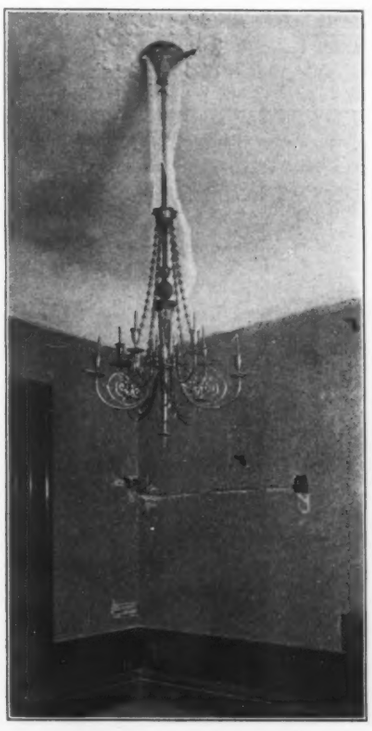


FIG. 3.—CHANDELIER AND SIDE WALL OUTLET.

the chandelier is connected without any cutting whatever, the wires running above the lath on the ceiling; furring pieces being used in plastering the house. The box used to cover the gas pipe at the outlet has a lip in the side which is knocked out by a hammer blow so as to permit the box to be slipped over the pipe.

Fig. 4 shows how two outlets in the library were wired, the position of the outlets being fixed by gas brackets already in use. In this case a vertical chase was cut in the wall to the

first gas outlet, and then a chase was cut horizontally along the gas pipe to the other outlet. As is evident from the engraving, the plasterer had already begun working on these chases.

Fig. 5 shows an upper bedroom wired for chandelier lighting and for a drop lamp over a dresser against the back wall. The circuits in this room are overhead between the ceiling and joists and the hole shown above the dresser was made by a gas fitter.

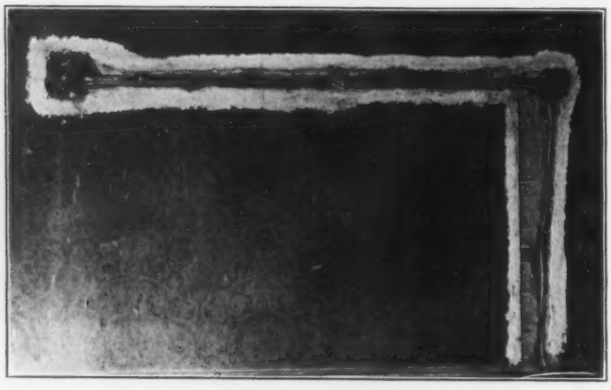


FIG. 4.—CONNECTING TWO SIDE WALL OUTLETS.

The circuit is fed into the chandelier from the nearest outlet and from there to the switch on the partition wall. A circuit also runs from the chandelier to the side outlet over the dresser. By this means the lamp over the dresser may be operated independently and is not under the control of the switch governing the lamps on the chandelier. In work of this kind it is not necessary to cut the walls at all. Fig. 6 shows the method of running the flexible armored cable. A pocket or board is taken up and the helper pulls in the cable at the other end, while the electrician guides it between the joists and lath.

Fig. 7 illustrates the method of installing the night or hall

FIG. 5.—BEDROOM WIRED WITHOUT CUTTING WALLS.

lamps and switches. The house being four stories high there is a lamp on the first, second and third floors, and these may be controlled from any floor. One wire of the circuit runs from the switch to the outlet on the third floor, to the outlet on the second floor and thence to the outlet on the first floor; the other wire connects each outlet with one side of the feeder. A three-way switch is placed on the first and third floors, and a four-way switch is placed on the second floor. The opposite side of the feeder circuit is connected to the switch on the first floor, and two wires run from the first switch to the four-way switch on the second floor, from which in turn two wires run to the three-way switch on the third floor. In this way multi-control of the lamps is provided, although there is no direct connection be-

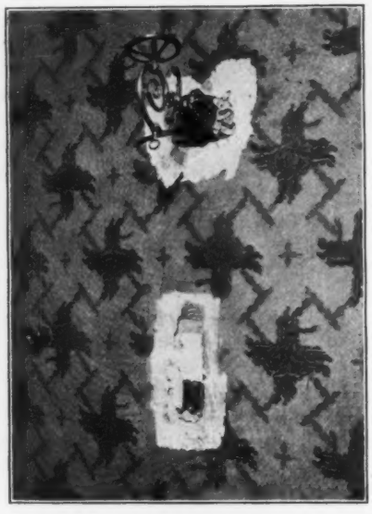


FIG. 6.—SWITCH AND OUTLET FOR HALL LAMP CIRCUIT.

tween the lamp and switch on the second floor. The plasterer in this case also is responsible for the appearance of the wall.

In work of this kind it is rather difficult to lay down any regular price for the work per outlet. It is usual where plans are prepared to measure the length of the circuits with a rotometer, add in the number of outlets, etc., required and then gage the cost of labor and the length of time required from experience and records of work of a similar nature. By means of records kept of other installations, a very close approximation of the amount of time required to make an installation can be made. The cost of material can be found exactly; but the item of labor can only be determined from past experience.

The illustrations show how very little cutting is necessary in a job of this kind. Were it not for party walls, the entire in-

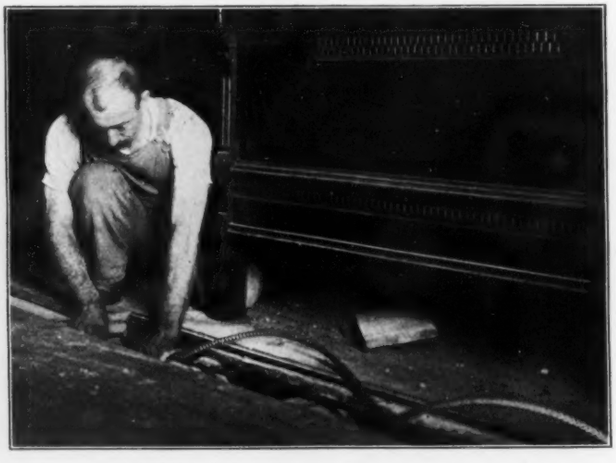


FIG. 7.—METHOD OF INSTALLING FLEXIBLE ARMORED CABLE ABOVE CEILING.

stallation could have been made with almost no cutting and without spoiling any decorations, although, as was pointed out, the house was to be redecorated, so that the latter consideration was not of much importance. The installation shown was made in New York City and fulfills all the requirements of the National Board of Fire Underwriters.

New Telephone Patents.

NEW APPARATUS.

With desk-stand telephones there has always been trouble from the twisting up of the cords as the stand is moved about. A taut cord largely overcomes the difficulty, but in order to obtain the advantages of it, at the same time retaining any degree of flexibility, a paying-out apparatus must be used. Such an apparatus forms the subject of a patent granted to Mr. J. H. Thomson, of Trenton, N. J. A reel is coupled to a coiled spring. The cord is fed into the shaft of the reel and thence is led to its surface and coiled. The leading-in cord is given a backward initial twist of a number of turns equal to one-half the maximum number of turns of the reel between its extreme positions. This apparatus is of doubtful real value from the telephone company's standpoint, as it is probable that the wear and tear upon cords feeding in and out will equal or exceed the damage due to twisting up of the cords.

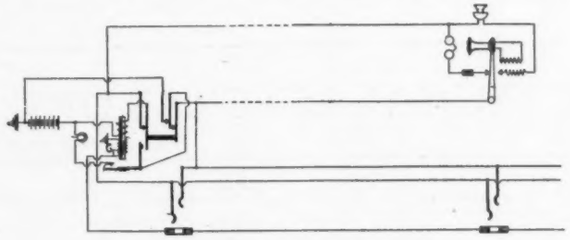
A keyboard key mounting has been patented by Mr. L. A. Binkman, of Chicago, the patent being assigned to the Kellogg Company. The invention lies in constructing the keys, levers and all as independent units. These are then mounted upon a mounting escutcheon plate which mounts upon the upper surface of the keyboard and covers the rough key slot therein. The key units are secured to the plate by means of screws, passing through small individual escutcheon plates, which span the keyboard, and into the key frame beneath the main escutcheon.

A counter for telephone stations has been patented by Mr. B. B. Brockway, of Cleveland, Ohio, the patent being assigned to the Dean Electric Company. The device, which is of the engine counter type, is mounted within the casing of the transmitter in a special recess formed for it. The counter lever operates a reed which is contained within the transmitter casing directly behind the diaphragm.

CIRCUIT SYSTEMS.

Mr. C. L. Goodrum, of Philadelphia, has patented a circuit system for a common battery switchboard. The cords are of the two-wire type, while the jacks are of the three-contact type. The line relays are shunted out by the insertion of a plug, while the supervisory relays are polarized and are operated by a reversal of the currents in them. These reversals of current are incident to the making and breaking of the subscriber's line loops at the hook switches. The Dean Electric Company has obtained the patent by assignment.

Most all common battery switchboards have required at least two separate devices to control their line lamp signals. One of these, known as the line relay, is used to cause the lamp to light, while the other, a cut-off device, has caused it to be extinguished upon the response of the operator. In an arrangement patented by H. G. Webster, of Chicago, these two functions have been assigned to one apparatus. This, a relay, operates part way to close the line lamp circuit in response to an incoming call, and completes its movement when energized more strongly upon the insertion of the operator's plug, while it performs all the cut-off functions in addition. Of course, such an arrangement may be designed and connected into the circuits in many ways, and Mr. Webster has endeavored to cover many of these in his seven patents, all of which are assigned to Milo G. Kellogg. The arrangements described provide for the differentiation of energization under the two conditions by the use of resistances, double-battery voltage and the use in different circuits of single, double and triple-wound relays and schemes adapted to both two- and three-wire multiple systems. The easiest of the circuits to understand is illustrated herewith, which shows a single-battery three-wire scheme that is practically self-explanatory.



WEBSTER TELEPHONE EXCHANGE.

Four additional patents granted to Mr. Webster relate to a switchboard system in which each line terminates in a repeating coil, the switching of the lines being accomplished solely by connecting the secondary sides of these repeating coils together. The repeating coil further serves a special purpose in each case in controlling the signals. In two cases the repeating coil serves as the actuating coils of a relay, in one case polarized and in the other not. In another instance the coil merely serves as a resistance coil as far as the signal circuits are concerned.

Still another patent granted to Mr. Webster refers to a means of improving ringing, by the clearing of the line during the ringing period. By the use of auxiliary contacts upon the ringing key and the addition to the line circuit of a limit relay, this latter is caused to operate only upon an excessive current supply furnished from the ringing key when this is depressed. The auxiliary relay while operated clears the line of all battery and signal connections, at the same time through its contacts controlling the signal circuits.

A. H. Weiss, of Chicago, has also obtained a patent for a switchboard circuit system, his patent being assigned to the Kellogg Switchboard & Supply Company. The system is of the two-wire type and is so arranged that there are no abrupt potential changes in the subscriber's line circuits due to the operation of the relays. The jack circuits are connected to the line circuit continuously, and the relays open the signal circuits only.

A circuit for a way station where telegraphy and telephony are carried on simultaneously over the same wire has been patented by Mr. I. Kitsee, of Philadelphia. The telegraph instrument is included in the main line, while a shunt is formed about it, including condensers and one winding of an induction coil. A telephone receiver is in circuit with the other winding of the induction coil.

LETTERS TO THE EDITORS.

Tungsten Lamps Abroad.

To the Editors of Electrical World:

SIRS:—I have read with a great deal of interest the article of Dr. Bell on the "Tungsten Lamp Situation Abroad" in your issue of Sept. 5.

While I was abroad, this summer, I had occasion to look into the matter of store illumination for a number of my friends. A large number of tungsten lamps were in use, a larger number in proportion to the total number of lamps installed than are used at the present time in this country. The life of these tungsten lamps, however, was very unsatisfactory to the consumer, as the percentage of early burn-outs was very high. Other lamps which did not burn out, blackened within the first few hours of burning. The number of lamps which went out of commission in these ways amounted to about 25 per cent, and as at that time the supply dealers did not guarantee the average life of the lamps, the consumer, as a rule, was not very much in favor of these lamps. They, however, used them on account of the increased candle-power obtained. From what I have seen of the tungsten lamps used on the Continent they seem to be inferior to the tungsten lamps that have been in use in the United States.

In going over a number of store and office installations I found that most installations have not been laid out with the view of getting all the illumination to be had from the lamps. Prismatic shades are a rather unknown quantity, the next best thing to them that could be secured being a poor imi-

tation made in Germany. A great number of the larger sizes of lamps were installed without any shades at all and the results were consequently very poor.

Albert Lea, Minn. Ludwig Kemper.

Silver-Thimble and Gun-Cap Cells Used on Atlantic Cable.

To the Editors of Electrical World:

Sirs:—I read with much interest Mr. Maver's account of the Atlantic cable of 1858, which appeared in your issue of Aug. 22 and in which an allusion is made to Latimer Clark's demonstration of the utility of low-tension currents for the transmission of signals through long submerged cables. It may be well to recall that experimental test.

Writing from Valentia on September 12, Latimer Clark says: "With a single galvanic cell, composed of a few drops of acid in a *silver thimble* and a fragment of zinc, weighing a grain or two, conversation may easily, though slowly, be carried on through one of the cables (1865, 1866) or through the two joined together at Newfoundland; and, although in the latter

GUN-CAP BATTERY.

case, the spark twice traversing the breadth of the Atlantic, has to pass through 3700 miles of cable, its effects at the receiving end are visible in the galvanometer in a little more than a second after contact is made with the battery. The deflections are not of a dubious character, but full and long, the spot of light traversing freely a space of 12 in. or 13 in. on the scale; and it is manifest that a battery many times smaller would suffice to produce similar effects."

Not to be outdone by the English electrician, Mr. William Dickerson, of the Anglo-American Telegraph Company, devised the gun-cap cell, which he used in 1866 with success in transmitting intelligence from Heart's Content, Newfoundland, to Valentia on the Irish coast.

A piece of No. 16 bare copper wire was procured, one end of which was firmly twisted around the head of an empty *gun-cap*. To one end of another similar length of wire was bound, with fine copper wire, a short strip of zinc bent at a right angle to form the anode element of the diminutive cell. After charging the cell with a drop of acidulated water of the size of an ordinary well-formed tear, and properly connecting the terminals with earth and cable, signals were transmitted over the cable by the infinitesimal current generated by this novel cell. The receiving operator reported that the signals were "awfully small"; but they were intelligible, and messages were successfully transmitted under the ocean by this tiny couple.

This interesting relic was presented several years later to Mr. H. H. Ward, of the Western Union Telegraph Company, New York, who kindly loaned it to us for illustration.

Contrast with this Lilliputian cell the enormous power that was used on the cable of 1858 toward the end of its short existence when batteries of 380 and 420 Daniell cells were employed to force signals across. When these failed, recourse was had to the excessive penetrative energy of an induction coil with the result that a cable costing millions did not long survive the ill-advised treatment to which it was subjected.

With regard to the retardation observed in signaling through submarine cables referred to by Mr. Maver, it might be recalled here that as early as 1816 Ronalds, the father of the electric telegraph in England, noticed and in 1823 clearly stated the retardation which an electric signal would undergo in passing through a long, underground conductor; but, though important and suggestive as it was, his pamphlet attracted no attention at the time. In 1838, Faraday commenting on Wheatstone's experiments on the "velocity of electricity," predicted that a retardation should occur on account of the electrostatic capacity of the line. Twelve years later, that is, in 1850, Dr. Werner Siemens, of Berlin, again called attention to this capacity effect in a paper which he sent to the Paris Academy of Sciences. But it was not until June 20, 1852, that the retardation was experimentally detected, being then observed by Mr. Latimer Clark on the London, Leeds and Liverpool telegraph line. The first public demonstration of the effect was given on Oct. 4, 1853, in presence of Faraday, Airy, Edwin Clark and other men of eminence in the scientific world. Some time later, Mr. Clark undertook, at the request of Professors Airy and Melloni, a series of researches on the transmission of the electric current which showed that, contrary to the belief of the time, the rate of flow of currents is independent of the electric pressure used; in other words, that high potential has no advantage over low potential so far as the velocity of transmission of a signal on land lines or submarine cables is concerned. Faraday expressed this by saying that "the force of a weak battery passes with equal rapidity along the line as that of a strong battery."

As might be expected, Faraday was greatly interested in the experiments on retardation which he witnessed and which, he said, "offered a remarkable illustration of the mutually dependent nature of induction, conduction and insulation." Accordingly, after further communication with Mr. Clark, he prepared a Friday-evening discourse, always a swell affair, on "Associated Cases of Current and Electrical Effects," which he delivered at the Royal Institution on Jan. 20, 1854. This circumstance gave rise to the impression that the experiments referred to in the lecture had actually been made by Faraday himself on subterranean telegraph lines. An equally erroneous statement is sometimes found in text-books and scientific periodicals.

Manhattan College, N. Y. City. Brother Potamian.

DIGEST OF CURRENT ELECTRICAL LITERATURE

Generators, Motors and Transformers.

Single-Phase Commutator Motors.—R. Goldschmidt.—A continuation of his long illustrated serial on the theory of single-phase commutator motors. In the present instalment the author first deals with the calculation of the core loss. When giving the same voltage, the core loss in an armature is smaller when excited with direct current than with alternating current. The simplest way of calculating the core loss in an alternating-current commutator motor where the maximum density has been found is as follows: Calculate the "alternating" losses in field and armature cores as with a transformer (allowing for extra eddy-current losses) and calculate the "revolving" armature core losses as with a direct-current machine, subtracting 15 per cent. Given the number of poles and frequency, the core loss, taken as the percentage of the output, is almost independent of the output of the machine. Speaking in a very broad way, the condition that, to obtain sparkless commutation, the flux must not fall below a certain figure can be expressed in the form: The core loss of the machine must not be less than a certain percentage of the output if the machine is to run sparklessly. The high core loss is one of the factors—but not the most unimportant one—limiting the frequency permissible with alternating-current commutator motors. It is interesting to see that the limit is about the same as that imposed, for instance, by the power factor and the losses in the resistance lugs. The author then briefly discusses the remaining losses and deals with friction loss and the copper losses. The article is to be continued.—Lond. *Elec.*, Sept. 4.

Eddy-Current Loss in Slot-Wound Conductors.—F. EMDE.—A highly theoretical paper. When an alternating current exists in a copper conductor embedded in an armature slot, Joulean heat is developed, and this is the greater the higher the frequency of the alternating current. It is lowest for direct current. Additional Joulean heat is generated in such a copper conductor when there is no electricity passed through it from the outside, if only other conductors are present through which alternating current passes. This is a case in which electromagnetic energy enters into a conductor from one side only. The author gives the mathematical solution of the problems involved, which are about the same as covered by Mr. A. B. Field in *Transactions* of American Institute Electrical Engineers, 1905, Vol. 25, page 761. But the mathematical method used is different.—*Elek. u. Masch.*, Aug. 16.

Lamps and Lighting.

Effect of Voltage Variation on the Life of Metallic-Filament Lamps.—H. REMANE.—A paper read before the German Association of Electrical Engineers. The author gives the results of extended life tests of osram lamps at voltages differing from normal. He points out that it is important to know the increase of voltage and the duration of this increase in lighting networks. A clear picture can be obtained, however, only by means of a recording voltmeter at the places where the lamps are to be used or at those points of distribution which are chiefly subjected to variations of voltage. It would be wrong to estimate the variation of voltage at a distant point from the voltage at the switchboard in the station. If the voltage is increased above the normal, the increase of the consumption of power would be proportional to the square of the voltage if the resistance of the filament remained constant. But since the resistance also increases, the power consumption increases less than the square of the voltage. This is shown in the first three columns of the adjoining table.

Per cent, v	v^2	w	r	cp	h	$u.\ l.$	*cp-hours*	K
100	100	100	100	100	74	1,800	100	1
105	110.1	108.5	101.3	121.5	27.6	900	61	2.68
110	121	117	103.4	143	13.8	370	26	5.36
115	132.2	125.3	105.5	167	8.0	210	15	9.25
120	144	133.2	108	193.5	5.4	125	9	13.7
125	156.3	142.7	109.6	221	2.9	70	5	25.5

The first column gives the voltage at the terminals of the lamp in per cents of normal voltage. The second column gives the square of the voltage in per cent. The third column gives the watts consumed by the filament in per cent. It will thus be seen that if the voltage is raised 5 per cent above normal, the voltage square is raised 10.1 per cent above normal, but the watts consumed are raised only 8.5 per cent above normal. The next column, marked r, gives the resistance of the hot filament in per cents of the hot filament resistance at normal voltage. As a result of an instantaneous raise of voltage above normal, the candle-power is instantaneously raised quite considerably above normal. An increase of the voltage by 25 per cent produces an increase of candle-power to more than twice the normal. But this increase of candle-power does not last long. Fig. 1 gives curves showing the mean results of tests of a large number of osram lamps, part of which were tested at normal voltage, part at 5 per cent above normal, and so on. All curves are of the same general character; the candle-power first increases above normal, passes through a maximum and then decreases, the decrease being the more rapid the higher the increase of voltage above normal. From the final parts of the curves (those parts of the curves in which the decrease of candle-power with time is represented by straight lines) the number of hours is found in which the candle-power decreases by 1 per cent. These figures are given in the column of the table marked h. They correspond, therefore, to the gradient of the straight line parts of the different curves in Fig. 1. The relation between actual life and useful life (the latter being defined as the number of hours within which the candle-power drops to 80 per cent of the original value) is quite different with carbon lamps and metallic-filament lamps. With metallic-filament lamps operated at normal voltage the actual life is longer than the useful life. That means if an osram lamp is carefully handled, kept free from vibrations and is operated at normal voltage, it will decrease its candle-power to 80 per cent of the original value after 1800 hours; but under ordinary conditions of practice the filament will break before that time and if it breaks, for instance, after 1000 hours, the candle-power will have decreased by only 7 per cent of the original value. When operated at a voltage higher than normal, both the useful life and the actual life decrease, but the useful life decreases more quickly. The useful life for the different curves in Fig. 1 is indicated by the figures marked h (meaning hours). The same figures are given in the table under $u.\ l.$ The next column in the table gives the actual cp-hours during useful life. It is marked cp-hours. By comparison of this column with the other column marked cp (representing the candle-power immediately after increase of voltage) it will be seen how insignificant the gain is due to the high increase of candle-power in the first moments. The reason is that the candle-power drops very quickly. For instance, if the normal voltage is raised by 10 per cent, the candle-power is instantly increased by 43 per cent, but the total cp-hours during useful life are reduced to one-fourth the value at normal voltage. The last column of the table marked K gives figures of what the author calls the "over-heating coefficient." They are found from the figures h, and give a direct indication of the decrease of a life due to increased voltage. For instance, if an osram lamp is operated for 100 hours at a constant voltage of 5 per cent above normal, K is 2.68; that means 100 hours at 5 per cent above normal voltage are equivalent to $100 \times 2.68 = 268$ hours at normal voltage; hence, the normal life is reduced by 168 hours. Or, if an osram lamp is operated for 100 hours at 10 per cent above normal voltage, these 100 hours are equivalent to 536 hours at normal voltage because $K = 5.36$. Hence the normal life is reduced by 436 hours. In this way the coefficients

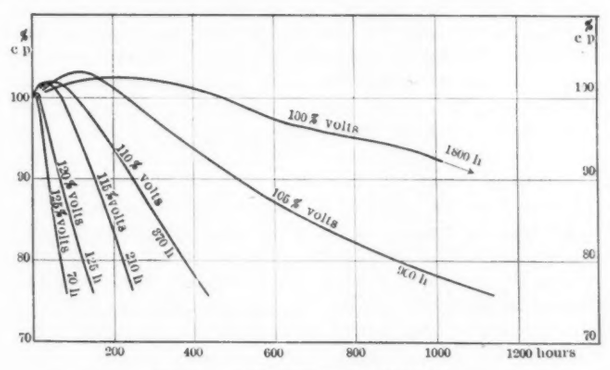


FIG. 1.—CABLE-POWER VARIATION.

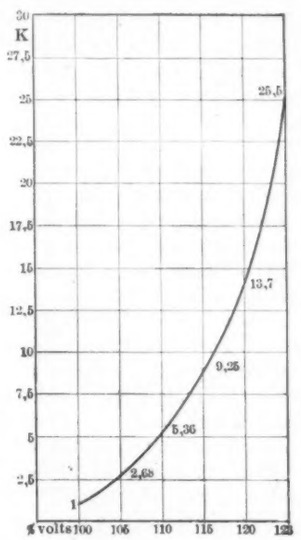


FIG. 2.—OVERHEATING COEFFICIENT.

K enable one to estimate the reduction of life of osram lamps if operated for a known period at an increased voltage. The values of K are plotted diagrammatically in Fig. 2.—*Elek. Zeit.*, Sept. 3. (In the discussion of this paper it was pointed out that these tests were made both with alternating current and direct current, and essentially the same results were obtained in the two cases. Blau also explained the application of the coefficients K in practice. If the different voltages to which the lamp is to be subjected during life are known, together with the duration of increased voltage, a simple multiplication of the hours with the corresponding K and addition of all products enables one to find the life.—*Elek. Zeit.*, Aug. 30.)

Metallic-Filament Lamps.—For 200 volts or more, metallic-filament lamps must have such a considerable length as to offer great difficulty in manufacture. Various inventors endeavor to overcome this difficulty by additions to the pure metal to increase the specific resistance. A process of this kind is that of the Watt Company, which makes filaments from a tungsten alloy with titanium or thorium or vanadium. The process consists in intimately mixing powdered tungsten with powdered oxides of the above metals and a binding agent containing carbon. The proportion of pure metal in the filament should be only just sufficient to render the cold raw filament a conductor. The paste formed is shaped into filaments, and these are heated in a chamber from which air is excluded. After the above treatment the filaments are raised to a white-heat temperature in an atmosphere of hydrogen. The oxides are reduced with the aid of the carbon in the binding agent and the hydrogen and an alloy of the tungsten and the metals from the oxides is produced. The value of such an alloy as, for instance, tungsten with thorium or titanium, resides in the fact that it has a high melting point and a much higher specific resistance than pure tungsten. The Union Company has developed a process which is intended for the same purpose, but is entirely different. The final filament consists of tungsten or molybdenum or an alloy of these two metals and silver. The incorporation of silver into the filament is said to increase the specific resistance and to render the filament less brittle. The process consists in heating carbon filaments to a temperature of 600 deg. C. by passing electricity through them, and at the same time exposing them to the action of the vapors of salts of tungsten or molybdenum, such as the chlorides, which readily evaporate in a vacuum. Hydrogen is introduced at the same time, and the metals are deposited on the carbon filaments, the chlorine combining with the hydrogen. The silver is incorporated into the filaments either beforehand by treating the carbon filaments with a solution of a silver salt, or at the same time by introducing silver chloride along with the tungsten and molybdenum chlorides. If desired, the carbon can then be completely burned out of the finished filament by raising the whole to a high temperature in an atmosphere of hydrogen.—Lond. *Elec. Eng'ing*, Sept. 3.

Alternating-Current Arc.—C. E. Guye and A. Bron.—An account of an extended series of experiments on the steadiness of the alternating-current arc as a function of the atomic weight of its metal electrodes. The authors call attention to the important part played by the period of extinction on the potential difference across an alternating-current arc between metals, even when this arc appeared quite steady. In general, the effective potential difference increases with the atomic weight of the metal electrode. It seems that the potential difference for the same length of arc and current strength can be attributed to the greater or less duration of the period of extinction which should increase as the atomic weight of the metal electrode is raised. In other words, in order that the arc may restrike every period the potential difference which immediately precedes such restriking must reach a higher value the greater the atomic weight of the metal. The explanation which appeared the most simple and probable depends on Dulong and Petit's law. The specific heat being inversely proportional to the atomic weight, it follows that the decrease in temperature of the cathode which occurs at each extinction is greater the greater the atomic weight of the metal. It is, therefore, obvious that to restrike requires a greater difference of potential, and thus a longer period of extinction.—Lond. *Elec.*, Aug. 28.

Ultraviolet Light.—A full account of the discussion which followed the recent paper of Schanz and Stockhausen on bad effects of ultraviolet light from electric lamps on the eye. The paper was abstracted in the Digest Sept. 5. Most of the speakers severely criticised the results of the authors, which were not thought to be conclusive. It was emphasized that ultraviolet light is present in ordinary daylight, and in order to prove that the light from electric lamps is dangerous it would be necessary to prove that they send out more ultraviolet light than is contained in daylight. (That they do not do so in general was proved by the experiments of Voege, abstracted in the Digest, Sept. 5.)—*Elek. Zeit.*, Aug. 27.

Generation, Transmission and Distribution.

Power Stations in Southern France.—A very full and profusely illustrated article of 28 pages on the various power stations which supply energy for traction, lighting and industrial purposes along the Mediterranean coast in southern France. The different systems are interconnected and receive energy from a large number of stations. There are seven large hydro-electric plants and numerous steam plants, which act as reserves. A description is given of the latest plant, the Brillane works, which has a rating of 12,000 kw, and supplies three-phase currents at 5000 volts to two transformer stations. The different transmission networks, substations and supply districts are also described.—*La Revue Elec.*, Aug. 30.

French Power Company.—An illustrated description of a plant supplying energy for lighting and traction to several towns in the industrial district of Lille, in the north of France. The equipment, when complete, will provide for an output of 25,000 kw and will contain 40 boilers, of which 16 are now installed, and seven turbo-generators varying in rating from 1500 kw to 5000 kw, of which four are already complete or in course of erection. Three-phase energy is generated at 10,000 volts and transmitted partly by cables and partly by overhead lines to various substations.—Lond. *Elec. Eng'ing*, Aug. 27.

Electric Motors in Salt Mines.—H. R. Speyer.—An illustrated description of the electric equipment of a group of salt mines in the Harz Mountains, in Germany. Energy is generated at a steam-driven station, owned jointly by the several mining companies. Electric driving is used for main winding engines on the Ilgner system, and for auxiliary three-phase winders, and three-phase motors are employed for underground haulage, aerial ropeways, tippers, elevators, cranes, pumps, crushing mills and various other purposes.—Lond. *Elec. Eng'ing*, Aug. 20.

Substations.—E. Le Fevre.—An illustrated article on the lay-out of an energy distribution system. A single-phase high-tension network is considered in course of development. Transformers are placed at the premises of the different consumers. The problems to be considered are, first, how to supply energy to prospective consumers from substations and, second, whether it will pay to substitute substations for the isolated transformers of the present consumers. Various points which are to be taken into account are discussed with the aid of diagrams. One of the conclusions reached is that only in rare cases will it be advantageous to substitute substations for existing isolated transformers.—*La Revue Elec.*, June 15. Some critical remarks are made by Brylinski on the same subject. He comes to the conclusion that, with the exception of special cases, distribution from substations appears to be the most advantageous solution. —*La Revue Elec.*, Aug. 30.

Pulsating Load.—I. Doery.—A discussion of the oscillations of the power developed by a three-phase motor when driving a machine with a periodically varying load. Ehrlich has recently treated this problem mathematically and the present author shows how to reach the same conclusions by comparatively simple considerations.—*Elek. u. Masch.*, Aug. 16.

Energy Distribution.—O. H. Wildt.—A discussion of some commercial aspects of electric energy supply. It is thought to be bad policy to try to introduce electric motors in works equipped with large steam engines. The object should be to try to get the whole of industries using small and medium motors as customers and to offer energy at greatly reduced though still remunerative rates. The erection of substations

should be studied with storage batteries to supply energy for the lighting load.—*La Revue Elec.*, Aug. 15.

Steam Turbines.—The two hydro-electric stations of Montbovon and Hauterive are equipped with four 1200-hp generating sets and with six generating sets, respectively, producing three-phase currents at 8000 volts. As a reserve for both stations a steam plant has now been erected; it contains at present a 1600-kw turbo-alternator. The steam turbine is of the Ratau type and runs at 1500 r.p.m. Results of tests of the turbine are given in the form of a table and diagram.—*La Lumière Elec.*, Aug. 22.

Gas Power.—From an account of tests made by A. Witz and E. François of a 1000-hp gas engine operated with producer gas with coke of pure quality containing 22.3 per cent of ash. The gas engine was directly connected with an alternator. One useful hp-hour requires 608 grms of coke. An efficiency of 35 per cent is estimated.—*La Revue Elec.*, June 30.

Traction.

Glasgow.—An abstract of the last annual report of the Glasgow tramway system, which is one of the oldest municipal tramway systems in Great Britain. The total mileage worked by the city is 179 miles. The total working expenses per car-mile were 11.786 cents in 1907-8, against 11.442 cents in the preceding year. The total expenses, including the capital charges, were 20.286 cents, against 19.550 cents in the preceding year. The total income from all sources was 21.186 cents, against 21.212 cents in the preceding year. The total kw-hours generated during the year were 28,662,621, as against 29,653,678 in 1906-7, the decrease being due to the fact that the electricity department took no energy during the year. The load factor of the total load was 38.3 per cent. The coal consumed per kw-hour generated was 2.97 lb. The total number of car-miles run during the year was 20,766,722, against 20,350,367 in 1906-7, an increase of 416,355.—Lond. *Elec.*, Aug. 28.

Interpole Traction Motors.—An illustrated description of traction motors with commutation poles, made by a British company for use on roads where extensive use is made of electric braking and where the duty is more than ordinarily heavy. —Lond. *Elec.*, Sept. 4.

Installations, Systems and Appliances.

Electric Equipment of a Business House.—An illustrated description of the use of electric lamps and motors in a large business house in London. Direct current is obtained on the three-wire system at 2×240 volts. The interior lighting is carried out chiefly with 220 inverted arc lamps, but a large number of metallic-filament lamps are also employed. All the arc-lamp circuits, each consisting of five lamps in series, are brought down to a central distributing board. Two hundred arc lamps are 8-amp and 20 are 5-amp lamps. The former burn about nine hours and the latter seven hours before needing fresh carbons. The following arrangement is used to indicate when the lamps require trimming: After any particular group of lamps has been trimmed, a clock corresponding to the group is set to 12 o'clock; when the lamps are switched on, a solenoid and detent device releases the clock mechanism, and the clock thus registers the number of hours the group of lamps has been burning. The switchboard attendant can thus, by glancing at the clock, see at once when any group of lamps requires trimming and can also make certain that all lamps have sufficient carbon to last through the day. Electric energy is employed for driving fans, sewing machines and electric irons. The fans are used in connection with an elaborate ventilating system, the most interesting feature of which is the provision of 17 ozone generators.—Lond. *Elec. Eng'ing*, Aug. 27.

British Central Station.—An abstract of last year's financial report of the municipal electricity works of Burton-on-Trent. The operating cost per kw-hour generated in 1907-8 was 2.486 cents (against 2.180 cents in the preceding year), while the total cost, including capital charges, was 4.502 cents (against 4.266 cents).—Lond. *Elec.*, Sept. 4.

Wires, Wiring and Conduits.

Regulations.—At the recent annual meeting of the German Association of Electrical Engineers, a number of official regulations were definitely accepted. These are now printed in full. A set of regulations on the construction and testing of switches, fuses and wiring appliances will go into force on July 1, 1909. Rules on the designation of the terminals of machines, starting switches, regulating rheostats and transformers, as well as regulations on the construction of transmission lines in the neighborhood of tramway lines and telegraph and telephone lines, and especially at crossings, have been in force since July 1, 1908.—*Elek. Zeit.*, Sept. 3.

Telephone Wires.—T. NOWOTNY.—An illustrated description of the methods used by the Austrian Telegraph and Telephone Department for making joints on bronze telephone lines.—*Elek. u. Masch.*, Aug. 23.

Electrophysics and Magnetism.

Heusler's Magnetic Alloy from Non-Magnetic Metals.—J. G. GRAY.—A description of some experiments made with an alloy containing 25 per cent manganese, 12.5 per cent aluminum, a trace of lead and the rest copper. He investigated its magnetic properties at temperatures between 0 deg. C. and 400 deg. C.; the alteration in magnetic properties brought about by the heating and cooling; the magnetic properties at the temperature of liquid aid after the specimen had been heated and quenched. The magnetometer method of testing was used, the specimens being cylindrical. They were heated electrically in a coil of thin platinum wire wound non-inductively. The specimen was taken through a magnetic cycle at the temperature of the room, then heated, and the cycle gone through at various temperatures. The effect of increase of temperature is to diminish continuously the permeability and hysteresis of the material; at 310 deg. it becomes practically non-magnetic. Next the magnetic field is kept constant, and the temperature gradually increased until the magnetometer deflection became zero; the specimen is then allowed to cool, and magnetometer readings taken. The cooling curve did not coincide with the heating curve, the difference being most striking when the applied field was weak, the magnetic quality being to some extent destroyed. Subsequent heating and cooling results in a further diminution of magnetic property, and so far as the experiments go there is no appearance of a limit to this. The magnetic properties, when the specimen is quenched from a high temperature, are very remarkable. In the quenched condition it is almost non-magnetic at the ordinary room temperature, but on cooling to the temperature of liquid air, its permeability is much greater than that of the material in the normal or unquenched condition.—From *Proc. Roy. Socy. Edin.*, abstracted in Lond. *Elec. Eng'ing*, Aug. 27.

Short-Spark Phenomena.—W. DUDDELL.—A (Brit.) Phys. Soc'y paper in which the author describes two effects observed in connection with some measurements of the current in the secondary circuit of an induction coil. On introducing a small spark-gap into the secondary circuit, the secondary effective current increases enormously in value, and a deflection is produced on a galvanometer in the secondary circuit.—Lond. *Elec.*, Sept. 4.

Units, Measurements and Instruments.

Water Rheostats.—N. YOUNG.—An article recommending the use of a solution of a comparatively high specific resistance for water rheostats, since it is then possible to keep the electrodes

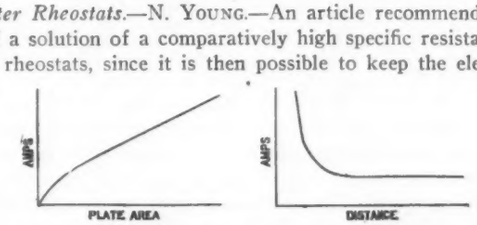


FIG. 3.—CHARACTERISTICS OF WATER RHEOSTAT.

close together. It is also advocated to use the solution at the boiling point, since at such a constant temperature there will not be the continual fluctuation of the load that occurs when working at any lower and unsettled temperature. The greatest advantage of working at the boiling point is that the latent heat can be taken advantage of, and a great saving in water is thus effected. Alternators of voltages up to 10,000 could be tested in a single tank with no more than 2 ft. between the electrodes,

which, of course, should be of suitably small proportions. Tests with two plates close together in a tank, which is itself large and roomy, have shown that the current, with a constant voltage, varies proportionally to the contact surface until a point is reached where the depth of the plate in the solution equals half of its breadth when the "curve rounds off." Further, the current varies approximately as the square of the distance apart of the plates. These two curves are shown in Fig. 3. The author explains the form of these curves, and then describes what he considers to be the best arrangement of a water rheostat. This is shown in Fig. 4, where three plates are arranged delta-wise. In practice they are bolted onto a rigid wood frame, and accurately spaced. They are of precisely similar dimensions, about 2.5 ft. x 3.5 ft., and are suspended and balanced by means of ropes run on insulator pulleys with weights attached. In use on a three-phase set, the plates can be canted, by lowering or raising one corner of the set; thus 10 per cent adjustment is available for equalizing the loads on the phases. They are immersed in a 5-ft. square wooden tank, and it will be seen that none of the more effective lines of current is interrupted. This tank, by simply varying the solution density, can be, and has been, used unaltered on voltages varying from 65 to 1000 and on direct currents up to 2000 amp, and 1500 amp per lead three-phase. A steam heater is provided which brings the temperature to 180 deg. Fahr. before starting, and so insures a rapid start and an immediate reaching of the boiling point, and thus a steady load. Washing soda is used as the electrolyte. With this arrangement used as a load for a 480-volt, 125-kw set the author found a consumption of 76 gal. of water within six hours in a 600-gal. tank. These 76 gal. were added during the six hours, leaving the water level at the end at the same point as when started. The starting temperature was 120 deg. Fahr. and the temperature at the finish 210 deg. Fahr. No soda was added during the test.—Lond. *Elec. Rev.*, Sept. 4.

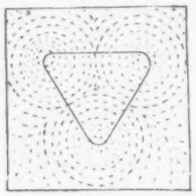


FIG. 4.—ARRANGEMENT OF WATER RHEOSTAT.

Mutual and Self-Inductance.—E. B. Rosa and L. Cohen.—A paper of 132 pages, giving a critical collection of formulas and tables for the calculation of mutual and self-inductance. The first part contains the various formulas for the mutual inductance of two coaxial circles; the mutual inductance of two coaxial coils; the mutual inductance of coaxial solenoids; the mutual inductance of a circle and a coaxial single-layer coil; the self-inductance of a circular ring of circular section; the self-inductance of a single-layer coil or solenoid; the self-inductance of a circular coil of rectangular section; the mutual and self-inductance of linear conductors, and formulas for geometrical and arithmetical mean distances. In the second chapter numerical examples are given to illustrate the use of the formulas and to test them. In an appendix the authors give tables of constants and functions useful in the calculation of mutual and self-inductance.—*Bull. Bureau of Stand.*, Vol. 5, No. 1, August.

Feebly-Damped Oscillations.—L. W. Austin.—A description of a method for producing feebly-damped high-frequency electrical oscillations for laboratory measurements. The general arrangement is shown in Fig. 5, where *B* is a circuit interrupter, *I* a reactance coil, *C* a paper condenser of from 0.1 to 1 microfarad, *T* a single turn of wire placed around a large inductance *L*, *V C* a variable air condenser, and *K* a coupling coil for connecting this oscillating circuit with the circuit on which the measurements are to be made. The action is as follows: When the direct circuit is broken at *B*, the self-induction current charges the paper condenser to a sudden high potential. This gives rise to a strongly damped pulse through the single turn of wire *T*, which starts the second circuit *L*, *V C* to oscillating in its own period, producing waves which are very feebly damped on account of its large inductance and negligible resistance. These can then be made use of for any experiments desired. For the greatest constancy of working the best results

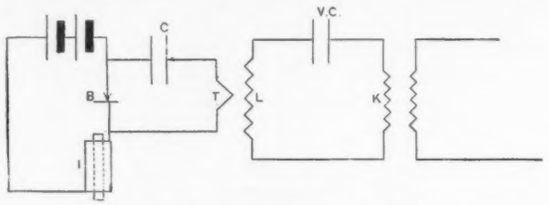


FIG. 5.—ARRANGEMENT OF CIRCUITS.

are obtained with a vibrating-wire mercury interrupter, as shown in Fig. 6, which is self-explanatory. The buzzer form of exciter is of great value in wireless stations for testing the condition of the receiver and for adjusting and making measurements on the receiving circuits. For testing the receivers it is greatly superior to the ordinary form of untuned buzzer, the use of which often leads to incorrect adjustment on account of the difference in behavior of many receivers to single pulses and to slightly damped wave-trains. If it is possible to

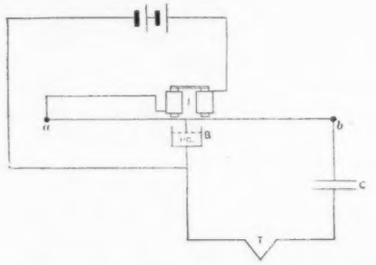


FIG. 6.—CONNECTIONS OF MERCURY INTERRUPTER.

insert an inductance in addition to the coupling inductance in the antenna, the single turn of the exciter circuit may be placed about this, thus exciting waves of the natural antenna frequency. This gives a convenient means of bringing the antenna circuit and the closed circuit to the same tune and of testing the receiver for the actual wave lengths which are to be used.—*Bull. Bureau of Standards*, August (Vol. 5, No. 1).

Electric Pyrometer.—In some cases it is not necessary to have a complete record of the change of temperature during the whole time of operation, since it is sufficient to know the maximum and minimum temperatures reached. This condition enables one to use a simple construction of recorder with a thermocouple. A pyrometer of W. Armour indicates by dashes on a time-temperature chart whenever a maximum or minimum temperature is reached. An automatic bell indicating a dangerous temperature is provided.—Lond. *Elec. Review*, Sept. 4.

Carbon-Dioxide Recorder.—An illustrated description of a new carbon-dioxide recorder of English make. The carbon dioxide is absorbed by caustic potash and the volume of the gas is measured before and after absorption of the carbon dioxide. Special attention is paid in this recorder to the filtering of the gas to remove any dust.—Lond. *Elec.*, Aug. 28.

Telegraphy, Telephony and Signals.

High-Spark Frequency for Wireless Telegraphy.—L. W. Austin.—Since practically all of the long-distance receivers used for radio-telegraphy make use of the telephone for the reception of signals, any circumstance which increases the sensitiveness of the telephone, increases the sensitiveness of the receiving apparatus in the same measure. From this point of view a high spark frequency should offer great advantages in wireless telegraphy. The experiments of the author show that high-resistance telephones, such as are used in wireless telegraphy, become much more sensitive with increase of frequency. It, therefore, appears that by increasing the spark

frequency at the sending station the effective sensitiveness of the receiving station can be increased many hundred times. This can be done, too, without entailing the difficulties connected with an increase in the sensitiveness of the wireless receiver itself.—*Bull. Bureau of Standards,* August (Vol. 5, No. 1).

Wireless Telegraphy in Germany.—The German Imperial Post Office has published a list of German radiotelegraphic stations for public service. The total number of these stations (coast and board) is 135, having ranges between 100 km and 600 km. Of these, 113 stations are equipped on the German Telefunken system, 16 stations on the Marconi system and six stations on the De Forest system. The coast stations at Arcona, Borkum, Bremerhaven, Buelk, Cuxhaven, Heligoland, Norddeich and Tsingtau are all open for public and limited public service, and also all lightship stations are open for public and limited public service. Further, all radiotelegraphic ship stations are obliged to communicate with other ships or coast stations irrespective of the system on which they may be equipped. The warship stations are only available for the service of the Imperial German Navy.—Lond. *Elec.*, July 10.

Sensitiveness of Detectors.—P. JEGOU.—The usual way of discovering improvements in the sensitiveness of detectors is to look for an increase of loudness in the telephone. Such an increase involves an effort of memory, and implies a considerable liability to error. The author has, therefore, devised a more reliable null method. The usual telephone transformer is split up into its two components. The secondary coil is placed in circuit with the electrolytic or other detector to be studied, and the primary, to which the telephones are attached, moves along a scale in close proximity to the secondary. The necessary e.m.f. is taken off a potentiometer, and the current is sent through the detector and secondary coil. The primary is displaced along the scale until the sound becomes inaudible. In testing the sensitiveness of an electrolytic detector at various temperatures, the author found that at a temperature of 12 deg. C. a displacement of 30 mm sufficed for extinguishing the sound, whereas at 60 deg., the temperature of maximum sensitiveness, a displacement of 56 mm was found to be necessary.—*Comptes Rendus,* June 15; abstracted in Lond. *Elec. Eng'ing,* July 2.

NEW APPARATUS AND APPLIANCES

Electrical Equipment in the New Plant of the Indiana Steel Company at Gary, Ind.

The new plant of the Indiana Steel Company, at Gary, Ind., has the distinction of being operated entirely from waste blast-furnace gases and also of being the most modern steel mill in existence. The plans call for 16 blast furnaces of the most approved type, eight of which are now completed or under construction. The most interesting feature in connection with these furnaces is the link connecting them with the power station and blowing-engine houses; that is, the gas-cleaning plant which adjoins the furnaces and stoves.

When the vast volume of dust-filled gas is blown to the tops of the blast furnaces, it passes from each, through four outlets, into two large pipes known as "downcomers," which lead into a reservoir, 30 ft. in diameter by 40 ft. high, called the "dry dust catcher." There a considerable part of the impurities settles to the bottom and the gas passes into another large pipe which leads upward some distance to increase the quantity of dust dropping and then turns down again, emptying into a supplementary tank, 14 ft. in diameter by 25 ft. high, one of which serves each pair of furnaces. This structure not only provides an additional dust catcher, but also acts as a valve, being divided into two compartments partially filled with water. By increasing the height of the water in either one, the furnace on that side can be cut off as desired, and there will be no back flow of gas from the mains beyond. The two chambers of this tank discharge into a pipe 10 ft. in diameter, which carries the gas and remaining impurities into the primary "wet" washers. There are three of these to each pair of furnaces and each has capacity sufficient to take care of the gas from a single furnace, thus providing a spare washer for use while one is being cleaned or repaired. The primary washers are cylindrical in form, with cone bottom and cone top, and are about one-third full of water, a proper overflow maintaining the required level. Here the gas and dust is discharged against the surface of the water from pipes with fluted edges like a petticoat, and the gas then escapes around these edges into openings from a larger main. At this point a small percentage of the gas is diverted to special furnaces under a battery of Rust boilers, used for making steam, and about 30 per cent is taken for heating the stoves. The remainder continues on to the secondary washers. First of this group are the vertical scrubbers, drums about 14 ft. in diameter by 50 ft. high. A torrent of water cascades down through the drum, and from near the bottom the stream of gas comes against it. Rising to the top the gas again passes on into what are known as Thiessen washers, of which there are four to each pair of blast furnaces. In each of these it is led between the wall of a cylinder and a revolving drum, armed with a series of paddle-like blades. A stream of water is spread into a film on the surface of the cylinder and the whirling drum throws such impurities as the gas still holds out against the water film, where they are caught and held. From these final washers the gas is conveyed under slight pressure to the holders, each of which has 200,000 cu. ft. capacity, from which it goes, as required, to the electric power station and blowing engine houses.

Sixteen blast furnaces produce about 44,900,000 cu. ft. of gas per 24 hours, equivalent, when used in gas engines, to 500,000 brake hp. Of this quantity approximately 30 per cent is taken for heating the stoves, 7½ per cent is diverted to steam boiler furnaces, 5 per cent is consumed by various auxiliaries or lost in the process of cleansing, 12½ per cent operates the gas-engine-driven blowers, and 45 per cent supplies the electrical power station.

The power station, which is 966 ft. long and 105 ft. wide, with 42 23-ft. bays, is located immediately adjacent to the blowing engine houses and between the blast and open-hearth furnaces. This places it advantageously for fuel supply and insures minimum lengths of transmission lines to the various departments using electric power.

In this station are installed 17 horizontal, twin-tandem, double-acting gas engines, turning at a speed of 83 1/3 r.p.m., 15 of which are designed for coupling to alternating-current generators and two to be connected to direct-current generators. The former are 25-cycle, three-phase, 2300-volt machines, and the latter deliver current at a pressure of 250 volts. The engines have a rating of 4000 hp, and the generators are rated at 2000 kw, but they are capable of carrying continuously 30 per cent overload. The 17 units were built complete by the Allis-Chalmers Company. The gas engines are said to be the largest in the world to operate on blast-furnace gas. The distinctive features of the engines are the simplicity of design, the solidity of construction and quiet operation.

The engine frames weigh approximately 90 tons each, and one-half of each frame is buried in the foundation in order to raise the floor line to a point which will make the rods on the valve gear readily accessible. The floor space occupied by one engine is 70 ft. x 44 ft. The cylinders are 44 in. x 54 in. stroke, the crank pins are 20 in. in diameter, the shaft is 30 in. in diameter in the bearing, and the fly-wheel is 23 ft. in diameter.

weighing 200,000 lb. The pistons and rods are water-cooled, water being introduced at the center and flowing forward to a discharge in the frame for the front piston and backward to a discharge in the tail guide for the rear piston, each piston having its separate supply.

The valve gear is located between the engines, concentrating on a twin-tandem in such a way as to make it very convenient for the operating engineer. This gear is of the builder's standard stratification type and the engine operates with constant compression, thus tending to insure smooth running under the highly variable loads to which it is subjected. The igniters are electrically controlled and so arranged that the time of ignition may be regulated by a single hand-wheel. Direct current at 80 volts is used in the ignition system. Duplicate independent igniters are provided at each end of the cylinder to insure prompt firing of low-heat-value gases and also to avoid the danger of shut down due to short-circuit. The entire ignition system, from the motor generator set, which furnishes the energy, to the electrically-operated igniters, is very solidly built.

The alternating-current generators are of a type developed by the Allis-Chalmers Company for use with these engines. The direct-current generators have also been designed with particular regard to this service, but, in general, are similar to the Allis-Chalmer Company's standard engine-type machines.

In connection with the generators, Cutler-Hammer remote-control field rheostats and field switches are used. The controlling apparatus is located in the basement as near as possible to the generators and is operated from the bench board located in the power-house gallery. These rheostats are of the "cross-head" type. They are driven by means of vertical motors, and are provided with automatic devices which insure the stopping of the motor at either limit of the "cross-head" travel; that is to say, either when all resistance has been cut in or cut out of circuit. Means are provided also for operating these field rheostats by hand in case of damage to the motor.

The electricity generated will be distributed throughout the works and used to operate the heavy induction-motor-driven rolls, the tilting and feed tables for the various passes, the hot saws, hot and cold pull-ups, hot rolls, transfer tables, straightening and drilling machines, cold saws, elevators, conveyors, pumps and a multitude of machines and mechanical devices auxiliary to the operation of such an enormous plant. Several of the motors built by the General Electric Company for these works are rated at 6000 hp each, being designed for driving the rolls, and from this they range in size down to machines used to operate switches in the power house. The problems of control presented by the multitude of motors installed at this plant involved many interesting features, the solution of which was largely intrusted to the engineers of the Cutler-Hammer Manufacturing Company, of Milwaukee, and the automatic devices now installed at Gary represent the most recent developments in electric control as applied to steel-mill machinery. The electrical system as a whole is subject to central control at a switchboard operated from a gallery 16 ft. high. This switchboard, which was designed by the Western Electric Company, has the usual complement of instruments of standard types.

To aid in securing maximum economy under heavy fluctuations of load, by utilizing the full value of the generating power of gas, without regard to the amount of electricity required at any given time for the operation of the mills, a storage battery installation, furnished by the Electric Storage Battery Company, has been housed in a two-story building, 87 ft. long by 47 ft. wide, located near the power station. The batteries will be kept charged as nearly as possible to their full capacity in order to assist in meeting, for a considerable period of time if need be, any demands for excessive energy made upon the gas-engine-driven generators.

The control of the battery charge and discharge in respect to the 250-volt direct-current bus is effected by means of two motor-driven boosters which may be operated singly or in parallel, the field excitation being controlled by a carbon regulator with its solenoid in series with the total output of the direct-current generators. The fluctuations of load on the alternating-current circuit are transmitted to the battery by means of a split-pole converter designed to hold the constant alternating-current voltage while permitting a sufficient range of direct-current voltage to cause the battery to charge from or discharge into the alternating-current circuit through the converter. The field control of this converter to effect this variation in direct-current voltage is accomplished by a special alternating current-direct current exciter, which corresponds to the energy component of the alternating-current output from the alternators. The various motor-generator sets, converters, etc., comprising this regulating system may be started and stopped from the bench board in the switching gallery by means of Cutler-Hammer remote-control starting apparatus and the field strength of the various machines may be varied by means of remote-control rheostats. One of these remote-control starters used in connection with a motor-generator set, which is started from the direct-current end, is designed to carry 10,000 amp under maximum working load conditions. This is believed to be the largest remote-control starter ever built.

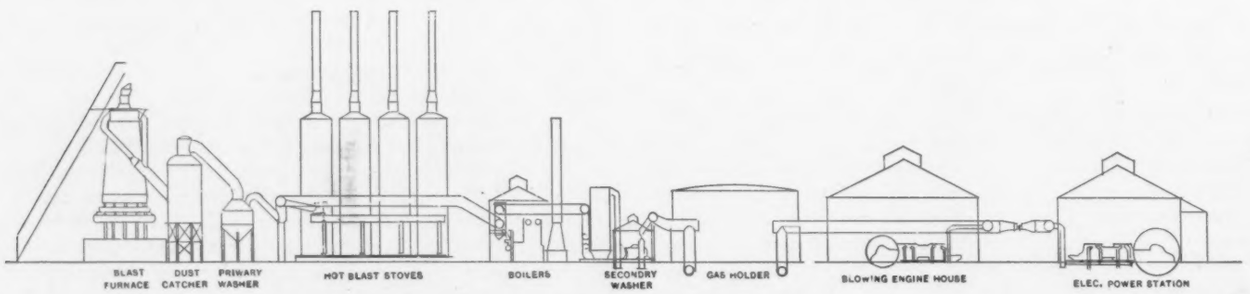


FIG. 1.—DIAGRAM SHOWING CIRCUIT OF BLAST FURNACE GASES.

The motor equipment in the various mills is very extensive. In the open-hearth buildings the traveling and fixed cranes are electrically operated. There is a 125-ton crane in the casting department and another in the charging side, and the ladles used in pouring off are rated at 80 tons. In the rail mill, the largest in the world, for the electrically-operated ingot buggies which transfer the heated ingots through the first stand of rolls, the Cutler-Hammer Manufacturing Company, of Milwaukee, has developed an ingenious system of control. On account of the length of the building in which the soaking pits are located it is impossible for the operator stationed at the mill to see when an ingot buggy is opposite a particular pit. It was, moreover, deemed necessary to guard against the possibility of the operator becoming confused and bringing both ingot buggies to the mill at the same time, which would result in a collision. The special controlling system provides guards against this contingency, at the same time enabling the operator automatically to stop the ingot buggy at any of the pits. There are two master levers for the control of the two buggies. Each of these levers can be set in any of eight positions, one corresponding to the rail mill itself, six to the six soaking pits, which each buggy serves, and one "off" position. If, when one

of the ingot buggies is at the mill, the operator desires it to go to pit No. 5, say, and there stop, he merely moves the controlling lever to the position corresponding to pit No. 5, and the buggy proceeds to that point and is there automatically stopped. A suitable interlock between the two controlling levers is provided which renders it impossible for the operator to throw both levers to the mill position at the same time, thus insuring a clear track for each buggy.

The rail mill is equipped with 12 sets or stands of roll trains, all operated at varying speeds by General Electric alternating-current motors, some of which are of the largest sizes ever constructed for industrial service. These are housed in a separate bay, or "lean-to," running parallel with the rolls. The rotors are 20 ft. in diameter and have a speed of 83 r.p.m. All of the motors are connected directly to the roll trains by regular mill coupling. The aggregate driving capacity is 24,000 hp. Although the motors are provided with fly-wheels and operate in one direction, provision is made for reversing in case of necessity. The control system has been worked out with the greatest nicety, all operations being under the instant control of the operator by means of a master controller.

The first group of rolls consists of four stands of continuous 40-in. mills, each two of which are driven by a 2000-hp motor. They are arranged in tandem, requiring no manipulation from stand to stand. Here, as elsewhere through the plant, sufficient distance is left between successive sets of rolls to enable a quarter turn of the ingot or bloom to be made, so that it is worked equally on all sides. The first two mills are at present equipped with 42-in. rolls, enabling 20-in. x 24-in. ingots to be used. After passing these four mills the ingot is sent to a 40-in three-high blooming mill equipped with lifting tables and arranged with a combined hydraulic and pneumatic balancing device. This mill, which is operated by a 6000-hp motor, gives the ingot five passes. After being bloomed the ingot is sheared in a 10-in. x 10-in. horizontal blooming shear, and the crop ends or butts are taken outside of the mill by a butt conveyor of unusual construction, which was designed and built by the engineers of the Indiana Steel Company. Each bloom then goes through a 28-in. roughing mill, which is three-high and equipped with tilting tables. This mill has actually three stands of rolls. The roughing stand, however, is the only one that is three-high, the other two stands being two-high. The mill is driven by a 6000-hp motor and gives the bloom three passes. After leaving the roughing mill the bloom goes through a two-high 28-in. forming mill driven by a 2000-hp motor, receiving but one pass. Then it is sent to a 28-in. finishing mill, which consists of five stands of 28-in. mills driven by two 6000-hp motors. After this, which is the dummy pass, the bloom is transferred to the first edging, which is in this same mill, but the second stand, and turns back on an elevated table to the second edging, which is a 28-in. roughing mill. It then travels by chain transfer to the lower tables and on the leading pass goes through a stand, which is also in line with the roughing mill and driven by the same motor, and continues on to the third stand of the 28-in. finishing mills, this being the eighteenth and last pass. After the finishing pass the rail travels through to the saws, of which there are five provided, thus cutting four rails to length. These four rail lengths consist of half the ingot. As the capacity of this mill is 4000 gross tons per 24 hours it will be seen that there must be a four-rail length sawed about every half minute. The saws are 42 in. blades, arranged to be raised and lowered in unison by one controller from the hot-saw operator. After leaving the hot-saw run the rolls pass over the usual cambering machine and are run onto hot beds 100 ft. long, of which four are at present installed, with provision made for an additional two, if necessary. These hot beds extend to the south of the mill proper. In the finishing mill section they are of unusual design, being made of structural material and placed 8 ft. above the floor, allowing for an extraordinarily large air space to facilitate the rapid cooling of the rails. The finishing building is 1383 ft. long, central with the hot beds, and provided with live rolls extending the entire length. The roller tables are equipped with stops and kick-offs to transfer the rails to the straightening process, of which there are 16, built by the Hilles & Jones Company, of Wilmington, Del., these being of the usual type and motor driven. From the straighteners the rolls are transferred by the usual skids to three-spindle vertical drill presses furnished by William Sellers & Company, of Philadelphia, which are also motor driven. These complete the rails for use. From the drill presses the rolls are transferred to a roller table, which extends the full length of the building and from which the rolls may be skidded to the loading beds immediately outside of the building.

FIG. 2.—VIEW OF SEVENTEEN GAS ENGINE-DRIVEN ELECTRICAL UNITS.

The principal machinery was built and installed by the United Engineering & Foundry Company, with the exception of that in the finishing department, which was erected by the Morgan Engineering Company. For the lifting tables and transfers Westinghouse motors are used.

In the rail mill a number of Cutler-Hammer automatic remote-control devices are installed, the most interesting of which are those designed for the control of the elevating and tilting tables, the bloom shear and the transfer. The elevating table on the 48-in. blooming mill, weighing about 250,000 lb., is supported on huge bell cranks which are connected to a rotating crank driven by a 250-hp motor operating at 150 r.p.m. By means of automatic controlling devices the throwing of a master lever starts the table from the low-level position and raises it to the highest level, where it is automatically stopped. In

lifting the table from the low to the high level, the rotating crank moves through an arc of 180 deg., and, on throwing the master lever to the reverse position, the crank revolves another 180 deg. in the same direction, bringing the table to the low level once more. The operation of raising or lowering the table can be accomplished in a period of two seconds, which is quite remarkable when the masses to be accelerated, slowed down and stopped are considered. Its arrangement is similar to that of the elevating table, one end being pivoted and the other end supported on a bell crank. The tilting table is driven by a 150-hp motor controlled by a controller similar to that designed for the elevating table. The bloom shear is operated by means of a 75-hp induction motor and the pin on the clutch by a direct-current auxiliary motor of 5 hp. The circuit of this motor is interlocked with the controlling device for the 75-hp alternating-current motor so that the former cannot be put in motion except when the latter is running at full speed. The latch is operated by a crank to which the 5-hp motor is geared. Pressure on a push button, under control of the operator, causes the motor to run long enough to revolve the crank 360 deg., thereby releasing the clutch and returning the pin to the initial or "off" position.

Automatic controllers installed in connection with motors on the transfers make it possible for the operator to transfer the rail from one table to another by a simple throw of the lever, the motor being automatically stopped after the transfer has been completed.

For the operation of cranes, tables and other apparatus, in and about the rail mill, requiring direct current, two 500-kw synchronous motors driving direct-current generators have been furnished by the General Electric Company. This equipment, with the necessary switchboards, is located in one of the motor houses at the rail mill and designated "Substation No. 1." Other substations suitably equipped are being located in other sections of the plant.

The billet mill consists of four continuous stands of 40-in. blooming mills, each two of which are driven by a 2000-hp motor. After leaving these the ingot is turned end for end on a turntable and passes through a five-stand 32-in. continuous mill, the entire mechanism of which is driven by one 6000-hp motor. At the end of this mill is placed a 12-in. x 12-in. horizontal blooming shear and also a 10-in. x 10-in. vertical blooming shear, from either of which shears either sale blooms or blooms for the 24-in. mill immediately following may be sheared. The sale blooms are run out on hot beds on the other side of the building, where there is a loading yard equipped with overhead traveling cranes. Blooms intended to be further reduced after being sheared are sent through the 24-in. continuous mill, which consists of six stands driven by a 6000-hp motor, reducing the blooms to 4 in. or 5 in. square. At the end of the 24-in. mill is placed a roller table. The billets may be transferred to an 18-in. continuous mill to be further reduced, or, if for sale, to a shear and from thence to overhead billet pockets, from which they may be loaded directly into cars.

For the further reduction of billets taken from the above-mentioned transfer skids the billets are run through an 18-in. six-stand continuous mill, driven by a 6000-hp motor and equipped with flying shears, so that billets reduced in this mill (1¾ in. and 2 in.) may be run out on covered hot beds extending at right angles to the general direction of the mill into an extension of the same billet loading yard as that provided for the 10-in. and 12-in. sale blooms. Provision has also been made for the installation of an additional continuous mill for reducing 4-in. and 5-in. blooms to such small sections as the trade may require. This mill will be located on the opposite side of the mill building from the 18-in. mill, thus providing additional capacity to take care of the enormous tonnage from the blooming mill proper.

All of the machinery is electrically driven, General Electric, Crocker-Wheeler and Westinghouse motors being used. This machinery was also furnished by the United Engineering & Foundry Company.

Water-Cooled Core-Type Transformers.

The accompanying illustrations show a line of transformers possessing many interesting features. It will be noted that the water-cooling coils are suspended from the cast-iron top of the transformer case. The transformer structure itself is also hung from the same cast-iron cover. The advantage of this method is that when it is desired to remove the transformer from its case it is simply necessary to lift the cover by means of eye bolts, which raises the water-cooling coils and transformer complete intact. This feature will be appreciated by central-station operators who may have been compelled to draw off the oil from a hot transformer underneath the surface of the oil in order to hook on the lifting chains so that the transformer could be lifted from its tank.

The water-cooling coils are of seamless brazed copper tubing, tested at 250 lb. hydraulic pressure, insuring protection against leaks through which the cooling water might escape into the oil and endanger the safety of the apparatus. The coils are arranged to be readily cleaned of any deposit.

The transformers are of core-type construction with a very liberal ventilating space between the primary and secondary coils, as well as between the winding and the core. The provision for liberal ventilation insures a strong flow of cool oil

FIG. 1.—INTERIOR VIEW OF TRANSFORMER.

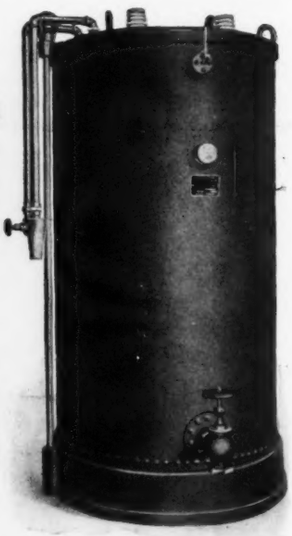


FIG. 2.—EXTERIOR OF COMPLETED TRANSFORMER.

from the lowest part of the tank up through the body of the transformer proper, where it then comes in contact with the water-cooling coils.

The transformer is mounted with top and bottom caps of cast iron, held together by the same eye-bolts which extend upward for the purpose of attaching the transformer to the tank cover. It should be stated, however, that after the transformers are installed the weight of the transformer rests upon the bottom of the tank for the reason that the nuts are backed off sufficiently to relieve the cover of part of the weight of the transformer. The tank is constructed of heavy rolled plate thoroughly riveted and calked throughout and tested by means of water pressure before shipment. An exceptionally large oil valve is supplied at the lowest portion of the tank so that the oil may be drawn from the tank very rapidly. The cases are equipped with oil gages and thermometers, so that the central-station attendant can at a glance determine the running conditions of each unit. All water piping, drainage cups, etc., for catching the exhaust water, are supplied in polished brass fittings, making a most finished and sightly installation.

This line of transformers has been developed by the Pittsburg Transformer Company, Pittsburg, Pa., which recently shipped nine 300-kw units of this type designed for 25 cycles, 6600-to-440 volts.

Progress in Electric Vehicles.

A striking feature of the electric vehicle industry is the fact that with almost no exception the vehicles built during the early experimental period are still in constant use and rendering reliable service. That is to say, in spite of their extra dead load, poorly proportioned parts, improperly distributed weight, high friction losses and great energy consumption, these vehicles were able successfully to displace horse-drawn wagons and have never been thrust aside.

It should not be concluded from the above that the machines of the present day are no better than the first ones manufactured. A fair indication of the progress that has been made in electric vehicles is found in the fact that while the older machines consumed about 100 watt-hours per ton-mile, the present-day equipments require only 65 watt-hours. Many factors have contributed to this result. Not the least important of these is the reduction in friction by the use of ball and roller bearings. Even a small decrease in friction produces a marked change in the energy consumption, the effect being cumulative. For instance, the simple decrease in friction without any other change would cause a decrease in energy consumption, so that the battery could be decreased in weight proportionately; a decrease in battery weight allows the framework to be decreased in size, reduces the dead weight, reducing the energy consumption, the battery weight and the friction loss itself.

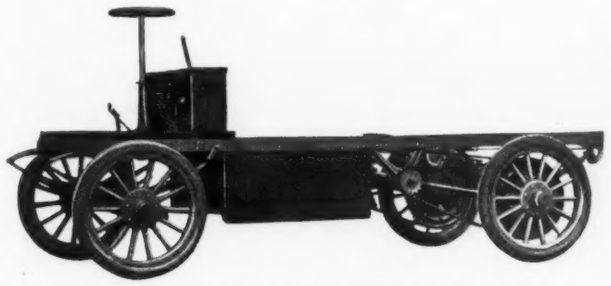


FIG. 1.—COMPLETE CHASSIS OF ELECTRIC EXPRESS WAGON.

In comparison with the early types of electric vehicles, the present-day machines carry much less dead load. Although the framework is much lighter it is much stronger and more substantial. Many parts that were formerly built of wood are now made of steel, while many of the old iron parts have been superseded by aluminum castings. In place of the older gears and friction drives, highly efficient silent-chain drives are now employed. Modern electric vehicles are built along well established engineering lines, and are more closely related to other types of electrical machinery than to horse-drawn vehicles.

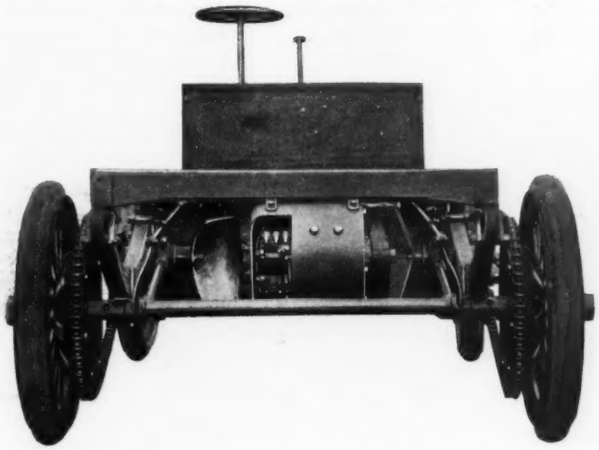


FIG. 2.—REAR VIEW OF A 1-TON EXPRESS WAGON.

Our readers are well acquainted with the more important characteristics of electric vehicles, but it may not be inappropriate to call attention to the status of the machine as a competitor to other types of vehicles. The electric vehicle should not be considered as a rival of the gasoline or steam touring car; its real field is that which in the past has been occupied by the horse-drawn vehicle. It is preëminently suited for use as a pleasure and business runabout, for public cab service and for rapid delivery and difficult haulage duty. Among its points of superiority over the horse-drawn vehicle are thorough cleanliness, reliability of service in any kind of weather over roads in any condition, long range of operation without relay, and less cost of haulage. Although each electric vehicle costs more than the equivalent horse-drawn vehicle, yet an installation of electric delivery wagons with their garage costs no more than the wagons, horses and stable required for the same amount of work.

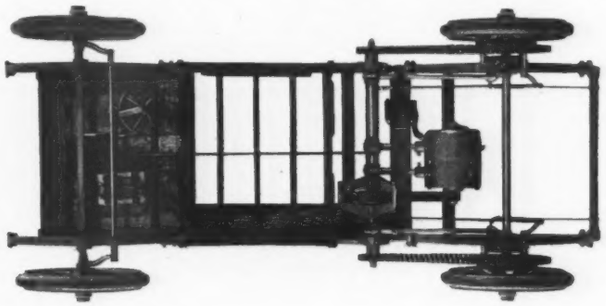


FIG. 3.—UNDER VIEW OF CHASSIS, SHOWING DETAILS OF DRIVING AND CONTROLLING DEVICES.

That the above statements have been borne out in practice is shown by the fact that companies which have substituted electric vehicles for horse-drawn wagons have universally been pleased with the change, and instead of returning to the old methods of transportation have gradually increased the number of electric vehicles in their service. The popularity of the electric vehicle is shown by the large output of the General Vehicle Company, Long Island City, New York, which has constructed more than 1200 wagons. The vehicles of this company are used by 100 commercial houses in 49 different cities of the United States.

As showing the present condition of the electric vehicle as a well designed machine, a description may be given of the standard delivery wagon built by the above-mentioned company. The framework is built up of steel channels, thoroughly riveted together, forming a rigid structure of minimum weight. The battery, which consists of 44 lead cells, is suspended below the main framework in a substantial cradle constructed of angle-irons. Each rear wheel is driven by a roller chain from a countershaft which in turn is connected to the driving motor by a separate silent chain; distance rods between the countershaft and the rear axle, and also between the countershaft and the motor, allows the chains to be kept always at the proper adjustment.

FIG. 4.—ELECTRIC TRUCK FOR A 3.5-TON LOAD.

The controller is of the continuous-torque type which changes the motor speeds without interrupting the power suply, thus giving a smooth, even acceleration without jar or strain of any kind. This arrangement gives maximum life to the battery, tires, motors, controller and driving mechanism. The controller arm is placed at the side of the driver while the controller is arranged beneath the seat.

The motor is a General Electric series-wound machine, arranged for two efficient running speeds; the field coils are connected in two groups, which are joined in series for the low speed and in parallel for the high speed. During the starting period a resistance is inserted in series to limit the current, but on running points no resistance is in circuit.

The motor is totally enclosed, is mounted high from the ground and protected from water and dirt. It can easily be reached and inspected from the rear of the wagon.

The countershaft, which is completely housed, contains a simple and effective differential mechanism. The wheels, springs, brakes and steering gear are of standard designs commonly used in the automobile industry.

The bodies of the trucks and delivery wagons are built according to the user's requirements. Most of the 1000-lb. and 2000-lb. vehicles are used for delivery and express service with closed or open covered bodies.

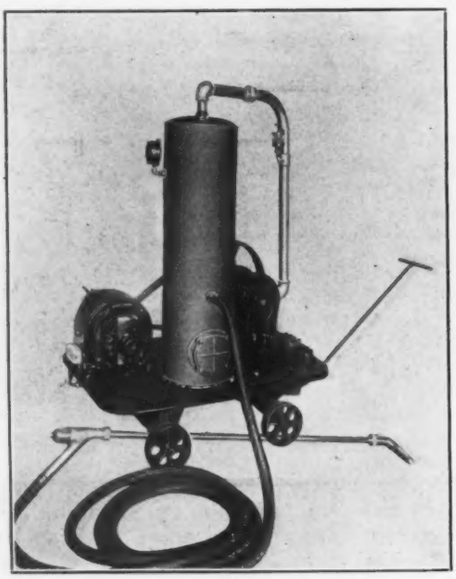
The heavier 4000-, 7000- and 10,000-lb. vehicles are used for draying and heavy trucking of all sorts of material from beer and beef to vinegar and sugar, with corresponding variety in body construction.

The effective mileage of the larger trucks varies from 35 to 25, and the speed from 11 to 6 miles per hour, the vehicles for the heaviest loads having less mileage and lower speed.

The smallest vehicle available is a 350-lb. light delivery wagon designed for quick deliveries. This wagon would seem to be adapted to central-station service for lamp and meter delivery. It is equipped for a distance of 50 miles on a single charge, and is geared for a maximum speed of 14 miles per hour.

Portable Vacuum Cleaning Equipment.

The National Vacuum Cleaning Company, of Dayton, Ohio, is making a portable equipment for vacuum cleaning which is driven by a 3-hp electric motor. This outfit, which is shown



PORTABLE VACUUM CLEANER.

in the accompanying illustration, makes a good compromise between the very heavy vacuum cleaning equipments for stationary use as installed in basements, and the very light portable ones which are taken from room to room. The advantage claimed for this portable equipment is that it can be taken from house to house by a man and connected at the service switch wherever electricity is available. Electric lighting companies can thus purchase them and rent them by the day. The truck, with 3-hp motor, rotary pump and tank, weighs about 800 lb. A smaller truck, with a 2-hp motor, weighs about 400 lb. An equipment of this kind was recently used for cleaning the offices of the Dayton Lighting Company, thus advertising this new possibility with electric service.

Copper Mining Electrical Plant.

The Famatina Development Corporation, which is interested in the development of copper mines near Chilecite, Argentine, is installing a hydro-electric plant, the generating equipment for which consists of two 200-kw, 240-volt revolving-field generators with direct-connected exciters, together with a suitable switchboard and transformers for stepping the voltage up to 13,200 volts. The generators are belt-connected to a line shaft driven by two Pelton water wheels capable of developing 630 hp at 300 r.p.m. The head is 230 ft., the pipe line being 6661 ft. in length.

In addition to the generating station there are also two substations, one located at the smelter, a short distance from the generating station, and the other at the mines. The power in the smelter is taken direct at the generator voltage, while that in the mine is stepped down from 13,200 to 240 volts. In addition to the apparatus mentioned above, the General Electric Company also supplied several induction motors of various sizes for use both at the mines and at the smelter.

This installation is comparatively small, but is interesting from the fact that a 20-mile transmission line will be erected from the generating station to the mines for transmitting only 100 hp (ultimately 200 hp), this comparatively large expenditure probably being due to the scarcity of fuel.

The San Anselmo Substation of the Northwestern Pacific Railroad Company.

It is contemplated to extend to Point Reyes, Cal., a distance of 20 miles, the third-rail system of the North Shore Railway Company, which now forms a part of the Northwestern Pacific Railroad Company, and is operated in connection with the latter's steam lines; and in designing the enlarged San Anselmo substation the increased needs of the service covered by this extension have been provided for.

The present electric traction system of the Northwestern Pacific Railroad Company starts at Sausalito, on San Francisco Bay, with terminii at Mill Valley, Fairfax and San Rafael, the longest single run being 13 miles. Energy is supplied from the company's own power house at Alto or taken from the long-distance transmission circuits of the California Gas & Electric Corporation, operating at a potential of 54,000 volts, three-phase, 60 cycles. The present equipment of the road is for direct current at 500-600 volts, but the Point Reyes extension will be a 1200-volt system, and provision has been made so that by proper combination of motor units trains may be run on either the 600- or 1200-volt service.

The new substation installation consists of two 500-kw revolving field, synchronous motor-generator sets, excited by a 30-kw induction motor-generator set, including a switchboard equipment and three 500-kw, 54,000-volt, oil-insulated, water-cooled lowering transformers. An interesting departure from ordinary practice is the method of excitation adopted. The exciter set generates at 600 volts and the synchronous motor fields are likewise wound for the same potential, so that exciting current may be taken in emergency cases from the "third-rail." The motor-generator exciter is of the two-bearing type, the induction motor operating at 850 r.p.m. at 2200 volts and is started in the usual manner. This single exciter supplies field current for both the motor-generator sets.

It will be noted that while the combined normal capacity of

the motor-generator sets is 1000 kw, there has been supplied 1500-kw capacity in lowering transformers. This is to provide for two additional motor-generator sets when the Point Reyes extension is built. These later sets will have the same characteristics as the present 500-kw sets and will operate two in series, thus delivering to that portion of the system intended 1200 volts. The switching equipment is such that any two machines may be operated in series, and with this end in view special insulation in the windings has been provided.

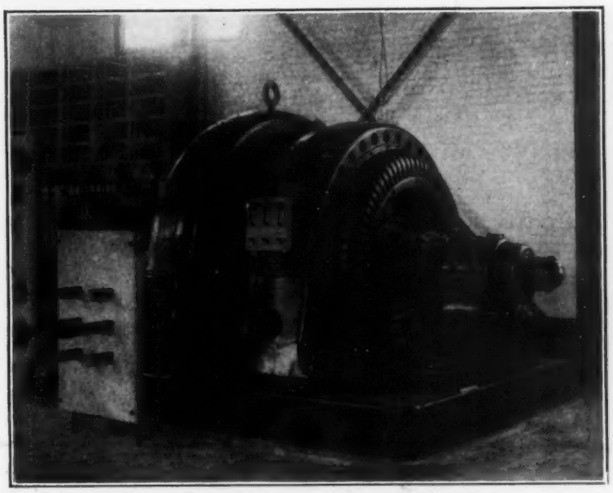


FIG. 1.—MOTOR GENERATOR.

The motor-generator sets consist of a 500-kw direct-current generator with synchronous motor, having common base, shaft and two bearings, making a compact unit occupying a minimum floor space. The synchronous speed of the unit is 600 r.p.m., and it is started from the direct-current end in the usual manner by graduated insertion of armature resistance, the starting current being taken through the third-rail from the Alto plant.

The synchronous motor is wound for 2200 volts, three-phase, 60 cycles, and is of sufficient capacity to drive its generator at 50 per cent overload for at least two hours, with a rise in temperature of the windings not exceeding 55 deg. C. above the temperature of the surrounding atmosphere, referred to 25 deg. C. The pole-pieces are easily removable, allowing convenient access to the stator windings.

The generators are of the eight-pole class, wound for 600 volts at full load and compounded for 550 volts at no load. The commutation is such that they will operate at full load continuously without sparking or burning at the brushes or blackening of the commutator; and from no-load to 50 per cent overload no adjustment is necessary.

FIG. 3.—HIGH-VOLTAGE TRANSFORMERS.

The 500-kw transformers are wound for 54,000 volts with taps for 36,000 and 45,000 volts; they are operated star-connected with the neutral grounded. The secondary potential is 2200 volts, delta-connected. They are of the shell type construction with coils mounted in vertical position, insuring good circulation of oil through liberal ducts between coils. The windings are in thin coils, one turn per layer, giving a maximum surface exposed to the cooling effect of the circulating oil and with a minimum voltage between layers. The cases are cylindricaliy constructed of boiler iron, riveted and calked. The insulation test was rigorous, consisting of applying 110,000 volts between high-voltage and low-voltage coils and case, and operating the transformers at twice the normal voltage, or 108,000 volts, for 20 minutes.

The installation is a credit to the engineers of the North-western Pacific Railroad Company and is the best development in this type of substation apparatus, being of particular interest to the engineer who has similar problems to solve. All of the apparatus was manufactured by Allis-Chalmers Company and is of its latest design.

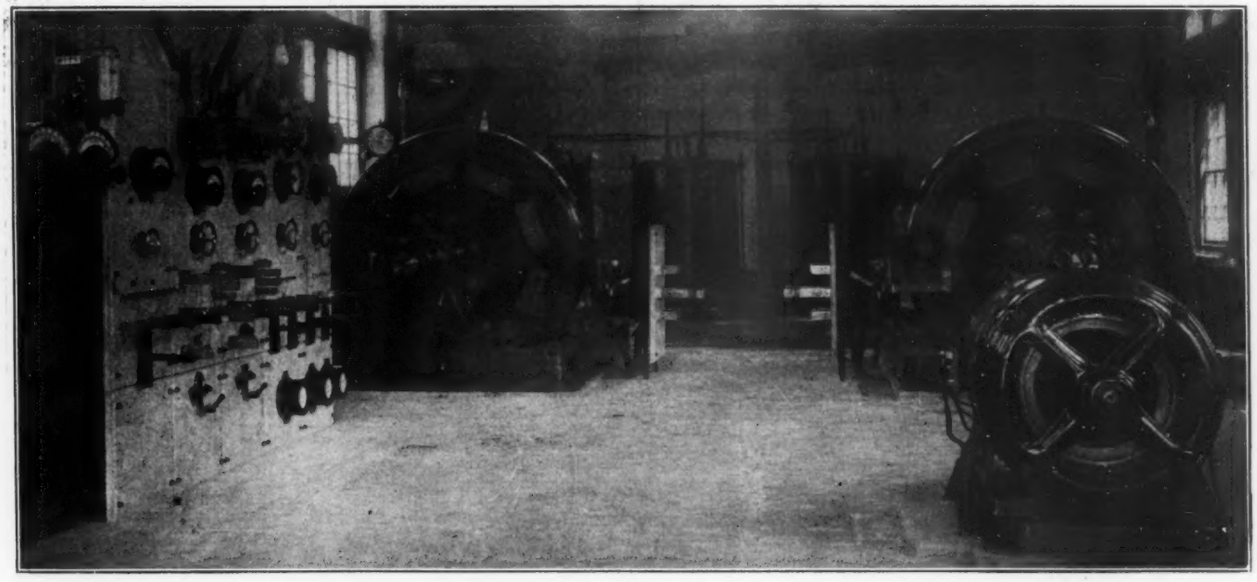


FIG. 2.—GENERAL VIEW OF INTERIOR OF SUBSTATION.

Electric Plant at Coeymans, New York.

The Atlantic Light & Power Company, at Coeymans, N. Y., was organized to supply energy for street and commercial lighting in Coeymans, Ravena and New Baltimore, and to lamps in the station and yards of the West Shore Railroad at Ravena.

The street lighting system consists of over 200 40-cp tungsten lamps on a series circuit, which are used on a contract of $20 per lamp per year. The railroad uses 21 arcs and 200 incandescents on multiple circuits. The present commercial lighting load is about 200 tungsten lamps, which the company furnishes to consumers at cost, and about 1500 16-cp carbon incandescents. The lighting rate is 12 cents per kw-hour, with a sliding scale of discounts. The motor service has not yet been developed, as the plant has been in operation only since Feb. 29, 1908. Preparation has been made on the switchboard, however, for a motor circuit. The motor rate will be from 10 cents down to 2½ cents per kw-hour.

The plant contains two duplicate 85-kw sets, making a total rating of 170 kw. It is intended, however, that only one set shall be used at a time, the other being kept as a spare. In case of an increase of the load beyond the rating of one set, duplicate additional sets will be installed. This provision has secured many customers for the concern, as it assures continuous service. The fact that the generators used are easily paralleled obviates the sudden fluctuations which occurred with the old service when throwing the load from one generator to another.

The power house consists of a brick and cement structure 32 ft. x 66 ft. and 18 ft. high at the eaves. The roof is of wood, covered with corrugated iron, and the floor of cement. The generating sets consist of Crocker-Wheeler generators coupled direct to Diesel oil engines. The engines, each rated at 120 hp and having three cylinders, 12 x 18, were built by the American Diesel Engine Company, of New York. They burn crude oil, which is injected into the cylinders by means of compressed air at a pressure of 900 lb. For this purpose each engine has belted to it an Ingersoll-Rand 9¼ x 3 x 10 two-stage compressor. Cooling water is circulated by a Pyramid 4 x 5 pump, belted to each set.

FIG. 1.—INTERIOR OF OIL-ENGINE STATION AT COEYMANS, N. Y.

Two 7500-gal. oil tanks are located about 30 ft. from the building. These are buried in the clay soil to exclude water due to sweating. In addition a 10,000-gal. tank is provided at the railroad, from which the oil is carried to the storage tanks in a tank wagon. A 14,000-gal. cooling tank is installed at the rear of the building. This is of wood, supported on a concrete foundation. The water is delivered as a spray at the top of a series of wooden steps down which it is allowed to drip to the tank.

The generators are 32-pole, 85-kw, 2300-volt, two-phase, 60-cycle machines running at 225 r.p.m. They were built by the Crocker-Wheeler Company, of Ampere, N. J., and are of the same general type as the larger machines built by the same company, which operate particularly well in parallel with each other or with machines of other types. The exciter belted to each generator is a 6.5-kw, compound-wound generator, running at 1100 r.p.m.

The switchboard is shown in Fig. 3. The first two panels are combined generator and exciter panels. The next two are feeder panels, each containing two single-phase circuits. Of these, one circuit is provided for commercial lighting in each of the villages of New Baltimore, Coeymans and Ravena, and the fourth circuit supplies the railroad lighting. Each of these circuits contains a Crocker-Wheeler single-phase feeder regulator, capable of regulating the voltage of the circuit 10 per cent above or below the busbar voltage. The fifth panel contains three 150-light series incandescent systems, for street lighting, with Wood regulators situated behind the board. Watt-hour meters are provided on this panel to check up the cost of the street and commercial lighting.

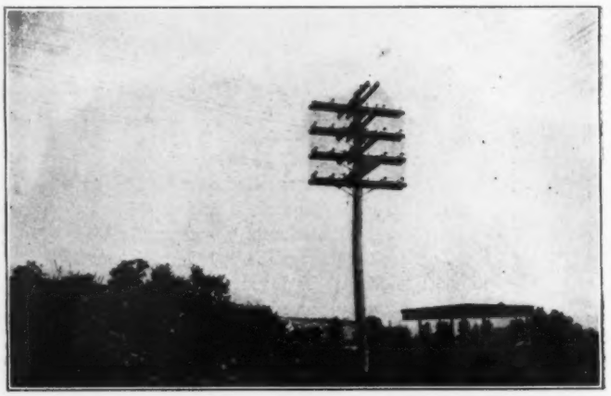


FIG. 2.—DISTRIBUTION POLE EQUIPPED WITH LIGHTNING ARRESTERS.

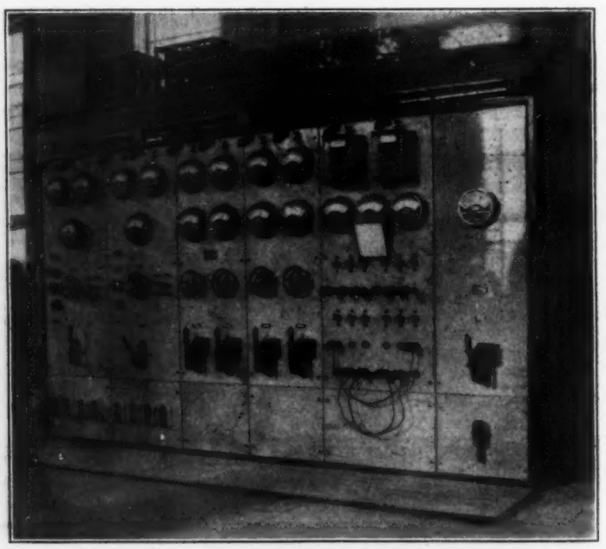


FIG. 3.—SWITCHBOARD IN COEYMANS STATION.

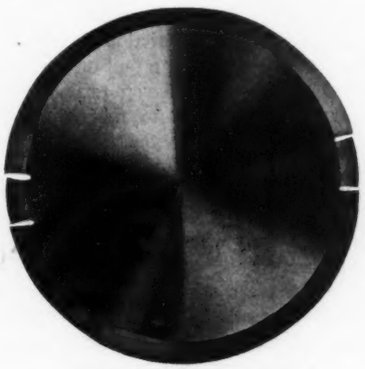
The poles are of such height that the wires are suspended above the lines of the telegraph and telephone companies and above the lines of the old lighting company, some of which still remain. All lines are provided with lightning arresters at the switchboard, at the first pole and at various points along the lines. All guy wires are provided with strain insulators to protect pedestrains, and pole transformers are grounded. Street lamps are permanently suspended from the poles on 6-ft. and 8-ft. arms of 1-in. pipe, from the ends of which the lamps are

insulated by means of glass petticoat insulators in Philadelphia fixtures, with General Electric sockets and receptacles.

The amount of fuel and lubricant for the engines is very low, not exceeding 40 gal. of fuel and 1½ gal. of lubricant per day for a run of about 60 hp for 10 hours and very light load for the other 14 hours. The president of the company is Mr. John N. Briggs, of Coeymans, and the consulting engineer for the plant is Mr. H. B. Sweet, of Utica, N. Y.

Copper-Clad Steel Wire for Line Work.

Attempts to combine in a single wire the tensile strength of steel and the conductivity and rust-resisting quality of copper have been numerous, such as the early process of depositing the copper upon the steel wire electrolytically and the more



COPPER-CLAD STEEL WIRE.

recent method of mechanically working a heavy sleeve of copper over a polished steel billet and then rolling the billet down and drawing it into wires of the desired gage. Objections offered to wire for transmission purposes made by these processes have been that in the former the copper coat was too soft to stand abrasion and in the latter the adhesion between the two metals was not great enough, despite the rolling and drawing, to prevent an infinitesimal film of air from remaining to start oxidation of the steel and finally cause the copper plating to flake off.

By a process recently perfected by J. Ferreol Monnot a homogeneous union between the two metals is brought about by applying a thick coat of copper to the outside of a billet of steel while both are heated to a high temperature, thus really welding the copper to the steel. The heat drives out all air and allows the plastic copper to mix with the softened surface of the billet most intimately. Any desired thickness of copper can be applied according to the requirements and the proportionate thickness remains the same in the finished wire. After cooling, the coated billet is reheated and run through rolls to reduce it to rods and finally to wire of ⅜-in. diameter. In the drawing mill this is then drawn down to wire of any size. The copper and steel draw down equally and the softer metal has the same thickness throughout. The rolling and drawing harden the copper so that it becomes very dense and in excellent condition to resist wear, and it is stated that so perfect is the union of the metals, even before rolling, that efforts to break the copper away with a hammer on a tongue made by sawing radially into the edge of a transverse section or disk cut from a coated billet have been unsuccessful.

The application of this process in the electrical field will be found in the manufacture of wire and cable for street railway overhead wires, telephone and telegraph wires on long lines, marine cables, electric light and heat cables and heavy feed wires for power transmission. While wire and cable produced by this method do not possess the same strength as all-steel wire of the same diameter nor as great conductivity as copper wire of the same size, it is claimed that great savings can be effected in the cost both of materials and labor, since the greater tensile strength and high elastic limit of the steel-clad wire will make fewer poles necessary and only so much copper will need to be used as is required to transmit the current, instead of, as at present, using an excess of copper to gain strength. For example, it has been found practicable in open line telephone work where heavy copper wire is used for its strength, although a smaller section would furnish ample conductivity, to substitute No. 17 copper-clad steel wire, which weighs only 64 lb. per mile as against 104 lb. for No. 12 copper wire and has a breaking weight of 334 lb. as compared with 318 lb. for the copper. Although the copper-clad wire necessarily costs more per mile than galvanized iron wire of the same or slightly larger size, it has several times the life of the iron wire, which will need to be taken down and replaced in seven or eight years, entailing double cost of purchase and labor, while the copper covered wire can remain up for 15 years.

Another evident application is to the transmission of power from generating plants at waterfalls. In this field the construction and maintenance of lines are large items of expense. The number of towers can be considerably reduced and less money invested in conductors than when hard-drawn copper is used. The greater strength and high elastic limit of the copper-clad steel wire are especially advantageous in carrying the line in long stretches across streams and chasms. This wire is made by the Duplex Metals Company, 208 Fifth Avenue, New York.

Steam Turbines in a Cotton Mill.

The increasing use of steam turbines in industrial plants is a striking testimony to their many good qualities. While admitting the advantages of high efficiency, compactness, simplicity, and the low cost of maintenance inherent with this type of prime mover, many are inclined to think that an excessive amount of auxiliary apparatus is required. The accompanying illustration, showing the interior of the power plant of the Nashua Manufacturing Company at Nashua, N. H., indicate the simplicity to which a properly installed turbine plant may attain.

Two 500-kw, 600-volt, three-phase Curtis steam turbines, one

FIG. I.—VIEW OF SWITCHBOARD AND EXCITER SET.

motor-generator set, one steam-turbine generator set, and a small circulating pump for the oiling system, constitute the moving apparatus in the station. The condensers, of the Manning-Bulkley type, are located on the outside of the building, where a sufficient head of water is provided for syphoning. No trouble is experienced in maintaining a vacuum of from 28 in. to 29 in., and as a consequence the only pump in the entire installation is the one furnishing oil to the bearings.

The excitation for the 500-kw units is provided at starting by the 25-kw Curtis turbine generator set. This set also furnishes power for operating the watchman's lights throughout the factory and for lighting the boiler and engine room. Continuous

excitation is furnished throughout the day by the 35-kw induction motor-generator set.

The switchboard consists of generator, exciter and feeder panels of blue Vermont marble, and is furnished with the necessary meters and apparatus for controlling the generators, exciters and feeder circuits.

The Nashua Manufacturing Company is an extensive manufacturer of cotton goods. The group system of electric drive is used throughout the mill, the motors being of the induction

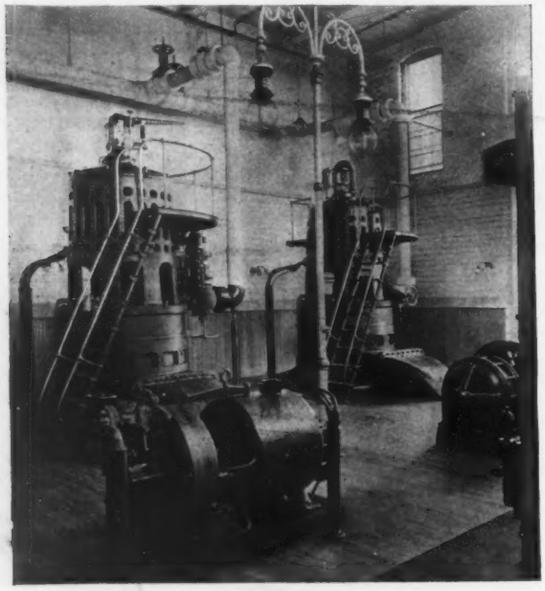


FIG. 2.—GENERAL VIEW OF GENERATING ROOM.

type, built by the General Electric Company. Besides furnishing current for the motors, the turbines also supply current for lighting the mill. An initial installation consisting of one 500-kw unit gave such satisfactory operation that two years later a similar unit was installed to meet the increasing demand for power. Space has been left for a third unit when future increase of business warrants its installation.

The first unit, after being in continuous service some 30 months, 10 hours per day, was taken apart and examined. The excellent condition in which the steel buckets and the entire interior of the turbine was found, refutes the popular belief that steam at high pressure, with more or less entrained water, acts as a corrosive agent on the turbine buckets.

Grab Bucket Mono-Rail Crane.

The mono-rail crane illustrated herewith is for use on an I-beam runway and is provided with swivel trucks so as to enable it to go around a curve of short radius. Both hoist and holding drums are operated by one motor, by means of friction clutches controlled from the operator's cage.

The lowering of the bucket and the operations of opening and closing it are effected by gravity. This method is considered far preferable to a crane having a separate motor for the hoist and holding line, especially on high lifts, since the rotative speed of the armature of a series motor in lowering the load will not exceed twice the hoisting speed; whereas with the gravity fall any speed of lowering can be attained, as the motor is inoperative when the bucket is being lowered or opened. After the bucket has been lowered for work, the clutch is closed, after which the clutch for the holding drum is engaged and the two are utilized for lifting the load. When the bucket has reached its highest position it is sustained by a self-lubricating mechanical brake of the double friction type, thus eliminating the necessity of constant care on the part of the operator and the liability of dropping the bucket should his attention be interrupted at any time.

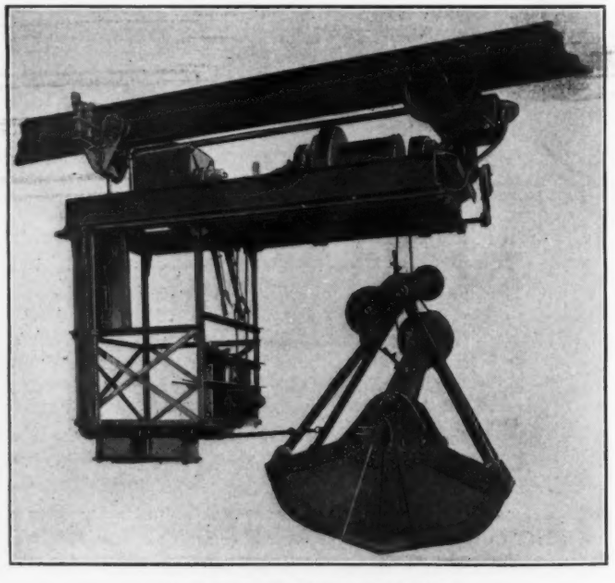
In order to relieve the hoisting clutches of undue wear during the process of lowering the bucket, the hoisting drums are provided with hand brakes controlled by foot levers from the operator's cage. The friction clutches used for raising the load act as safety devices in case of over-hoisting, since the clutches are so designed that they would slip before the stresses had reached a dangerous point.

The intermediate hoisting shaft is extended to the rear end of the operator's cage and is provided with a drum that rotates at about twice the peripheral speed of the hoisting drums. This drum has attached to it a rope which extends to the grab bucket and is used to steady it, not only while in the process of being elevated, but after the bucket has reached its final position and is being carried to its destination. The rope is always kept taut by means of a friction drum revolving between two disks keyed to the shaft with feather keys and held against the drum by means of spiral springs made adjustable for wear and also to vary the pressure between the friction services. The strength of the springs is such as to exert a pull on the steady rope from 250 to 300 lb. as the bucket is being raised or lowered.

A racking motor is attached to the driving truck and its speed is regulated by a drum-type controller located in the operator's cage. The travel of the hoist may be made to suit almost any condition, but in ordinary practice a speed of from 300 ft. to 500 ft. per minute will be found sufficient for coal handling plants, especially where there is a curve or bend in the I-beam along the runway.

The treads of the track wheels for the driving and trailing trucks are made spherical instead of cone-shaped as is sometimes done, the object being to eliminate friction as far as possible, as it is well known that a cone-shaped wheel running on the lower flange of an I-beam will have rolling contact along one diameter only, while the other parts of the wheel will be in sliding contact and subjected to undue wear as well as imposing an excessive load on the racking motor.

While compactness is desirable it was considered by the designer to be of secondary importance to accessibility; although the first has been obtained in a remarkable degree it was at no



GRAB BUCKET MONO-RAIL CRANE.

sacrifice of the second characteristic, the result being a skilful combination of the two features.

The hoist of the type illustrated herewith was designed to handle from 20 to 30 tons of coal per hour from a car or stock pile about 150 ft. distant from the power house, with a vertical lift of about 60 ft. The mono-rail hoist was designed and is built by the Cleveland Crane & Car Company, of Wickliffe, Ohio, under the direction of Mr. Thos. B. Davis, M.E., chief engineer.

Studio Lighting with Enclosed Arc Lamps.

In response to the demand for a suitable substitute for daylight to meet the requirements of color work, experiments have been carried on for several years under the direction of the illuminating experts of the General Electric Company. The enclosed arc-lamp was the most promising illuminant available. As ordinarily used the arc is found to be only fairly satisfactory. Extensive tests and practical experience showed that the desired improvement could be obtained by satisfying the following conditions:

1. Increasing the current of the direct-current lamp to about 6½ amperes and of the alternating-current lamp to 8 or 9

FIG. 1.—STUDIO LIGHTED WITH ARC LAMPS.

amperes. 2. Diffusing and mixing the light thoroughly, with properly designed reflectors and shades. 3. Insuring a sufficient intensity for the degree of accuracy desired.

An interesting installation of this type has been placed in the studio of the Chicago Portrait Company. In this company's large studio, which has an area of about 3000 sq. ft., are employed from 100 to 125 artists sketching in and coloring photo enlargements. The studio is provided with a saw-toothed roof and finished in a dull neutral gray, which provides an even, soft daylight illumination. The dull finish of the room makes it somewhat difficult to light artificially, yet under the pressure of the busy season the work has been carried on satisfactorily in the evening under the artificial light. Mr. J. S. Sharp, office manager, writes as follows:

"We are using 14 suspended ceiling-type diffusers, and are highly pleased with the results. We have been very successful in matching colors with this method of illumination. The

FIG. 2.—SHIPPING ROOM LIGHTED WITH ARC LAMPS.

almost perfect diffusion has reduced the shadows to the minimum."

The large studio is lighted by means of nine 6-amp enclosed arc-lamps with the suspended-type ceiling diffuser which has been developed by the General Electric Company. The lamps are hung about 15 ft. from the floor. In addition to this, a unit of the same type illuminates a small private studio. Four projecting-type ceiling-diffuser equipments with 6½-amp. lamps illuminate the shipping room. The latter room, in which portraits receive their final inspection, contains about 1700 sq. ft. of floor area and employs from 15 to 25 inspectors and shippers. The accompanying illustrations, which were taken at night, purely by the light of the lighting installation, illustrate the character of the rooms and the evenness of the illumination.

Colored Light Reflector.

The Lord Electric Company, New York, is placing on the market an incandescent lamp combination to replace the wasteful dipped lamp where color lighting effects are required. This con-

FIG. 1.—SELF-CONTAINED REFLECTOR UNIT.

sists in the use of a glass color screen and a reflector, which are fitted to the ordinary incandescent lamp bulb in the simplest manner. As will be seen from the illustration, the color screen covers half of the lamp surface, the other half being surrounded by an aluminum reflector. By this arrangement, all of the light from the lamp is reflected in the desired direction, instead of half

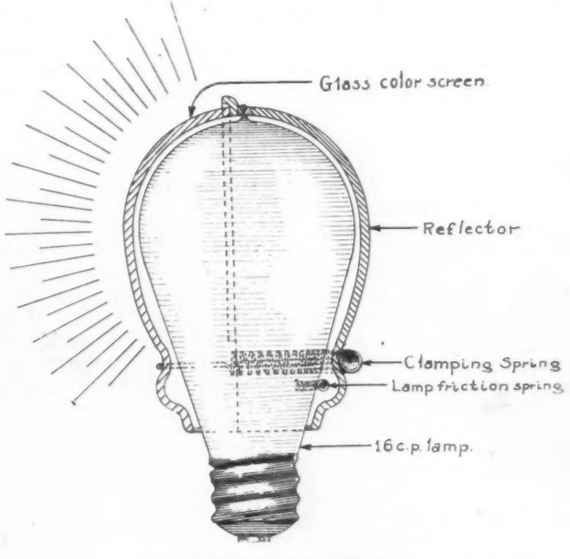


FIG. 2.—DETAILS OF REFLECTOR.

being radiated, as is usual, in other directions. Moreover, the glass color screen absorbs less light than the dipped bulb, which latter also requires to be redipped from time to time on account of the films chipping or flaking. The light from the screened lamp is also purer in color and, owing to the use of the reflector, more powerful in effect. The device is being marketed with the name "Leco" colored light reflector.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.

During the last week there seems to have been further moderate development in jobbing and wholesale lines, but the revival is so deliberate in its arrival that many business men feel impatient. The number of buyers in the jobbing centers is smaller than it has been during several preceding weeks, so that it may be taken that the fall buying has passed its maximum. Throughout the West, however, fairs and fall carnivals are attracting visitors to certain centers and are helping to improve retail trade. Purchases of fall goods have been made conservatively and have been confined largely to staples. Among the brass, copper and wire houses there is some business. It is expected, owing to the depleted state of retail stocks all over the country, that filling in orders will continue in fair volume and that when retailers finally conclude that the time for general replenishment has arrived they will have empty shelves. In the meantime there are many indications that prosperous conditions must come. The wealth of the country continues to expand, and the actual producers, especially the farmers, are certainly in better financial condition than ever before in the history of the country. One financial authority has made a calculation of the value of farm products based upon the government's statistics and the average values of Aug. 1, which shows a net return for the year 1908 of almost $8,500,000,000. This sum represents the new wealth added to the resources of the country during the year. It is the return from 6,500,000 farms, in the operation of which one-third of the people of the United States are occupied. This vast sum is divided about equally between the products of the field and animal, forest, fruit and by-products of the farm. The estimate, of course, is not accurate, but it may be taken as fairly approximate, variation in one direction being as probable as in the other. It presages a buying power that should be of encouragement to every selling community. Another feature which should cause encouragement is the large increase in the trade balance in our favor. The excess of exports of merchandise in August over the imports was about $19,000,000, and the excess of such exports for the first eight months of the year was $391,370,000, or just about twice as much as the excess for the corresponding period of 1907. Exports for the period have decreased, in keeping with the general contraction of business, but they have not fallen off in anything like the ratio of imports. The net addition to the wealth of the country is not affected by the volume of the trading. It is also encouraging that the gross earnings of railroads show a marked improvement since the beginning of September. For the first week of September the decrease in gross, compared with the corresponding week of last year, was only 10.42 per cent, the smallest ratio for months. A few roads show excellent increases. The early movement of crops is helping the railroads. All of these things promise well for the future, but patience and caution are necessary to take care of the present. Business failures for the week ended Sept. 17 number 266, as reported by *Bradstreet's*, against 191 for the preceding week, 179 for the corresponding week in 1907, 171 in 1906, 173 in 1905 and 203 in 1904.

THE COPPER MARKET.

The past week in the copper market has been one of little business and declining prices. The copper market is weaker than it has been for two months. The demand for consumption shows no improvement and the speculative buying abroad, which was the real sustaining element in the face of adverse statistics, has practically ceased. The pressure to sell by producers and dealers has resulted during the week in a decline of £1 per ton in London and ¼ cent per pound in this country. The only buying that has developed for export has been that of some foreign dealers who had previously sold at higher figures and found an opportunity to cover their contracts at a profit. There has been no evidence that the foreign consumers have been in the market. In addition to this some of the speculative standard contracts have been liquidated and this has added to the downward tendency. The United Metals Selling Company has again reduced its price in London, making a total of £2 per ton within 10 days, and independent interests are offering metal at a shade under the quoted prices. Domestic consumers have bought only in small lots and mainly from dealers who have been pressing sales in order to be able to take care of future contracts. Producers who have been willing to make concessions have found the demand light. The statistical movement continues to indicate further accumulation of stocks in this country and abroad. The total American production for the first eight months of 1908 is placed at 659,000,000 lb., the exports for the same period 466,000,000 lb., and the domestic consumption 220,000,000 lb. This would apparently indicate a consumption of 27,000,000 lb. from the large stock that was on hand at the beginning of the year, but as the imports have been more than that amount, the stocks have probably increased. The production of copper, however, has increased much more rapidly than the consumption. In August the American smelters turned out 99,000,000 lb. and the domestic consumption was less than 35,000,000 lb. Fortunately, however, exports during the same period were unusually heavy, amounting to 58,000,000 lb., thus checking what promised to be a very heavy addition to surplus supplies. Exports for September up to the close of business Sept. 21 were 13,909 tons, and will probably not reach more than 20,000 tons for the entire month. The production is as active as ever. Prices on Sept. 21, quoted on the Metal Exchange, were:

Lake	13¼ @ 13⅜
Electrolytic	13⅛ @ 13¼
Castings	12⅞ @ 13

The London market was as follows:

	Noon. £ s d	Close. £ s d
Standard copper, spot	59 11 3	59 10 0
Standard copper, futures	60 7 6	60 5 0
Market	Easy.	Easy.
Sales of spot		600 tons.
Sales of futures		900 tons.

Extreme fluctuations for the year:

	Highest.	Lowest.
Electrolytic copper, spot	13¾	12¼
Lake copper, spot	13⅞	12⅜
Casting copper, spot	13½	12⅛
London, spot	£64 5 0	£56 5 0
London, futures	64 10 0	56 17 6
London, best selected	67 10 0	60 0 0

GENERAL ELECTRIC FOREIGN ORDERS.—The General Electric Company has supplied a complete generating equipment to the Santos (Brazil) Dock Company, consisting of five 3000-kw, 2300-volt, three-phase, 60-cycle alternators, with exciters and switchboard equipment, and 15 1000-kw, 2300-44,000-volt transformers. Current will be transmitted 35 miles to a substation at the docks, which will also be electrically equipped by the General Electric Company. The same company has also supplied a generating and substation equipment to the Famatima Development Construction Corporation, of Chilecite, Argentina, the former for 13,200 and the latter for 240 volts, the electrical energy to be used in the working of copper mines. The Kobe (Japan) Electric Railway Company has ordered two 500-kw, 25-cycle, three-phase alternators, with marine-set exciters and switchboard equipment; a 40-kw motor generator as spare exciter, four 40-kw transformers and 100 GE-78 railway motors.

WILL BUILD TWO IMMENSE SWITCHBOARDS.—The consolidation of the American Telephone & Telegraph Company's facilities with those of the toll department of the Chicago Telephone Company will bring together the greatest equipment for long distance traffic ever contemplated. The plans call for the installation of two new switchboards at a cost of $300,000 Work on the American Telephone & Telegraph Company's switchboard has been begun already, and officers of the company say it will be in operation early next year. Both switchboards will be installed in the new toll building next to the general offices of the Chicago Telephone Company in Chicago. The present long distance switchboard, representing an investment of $125,000, will be discarded. Specifications for the Chicago Telephone Company's toll board are being made up, and it probably will be in operation a year from next January.

BED ROCK FOUND FOR HAUSER LAKE DAM.—Important borings have been completed by the Stone & Webster Engineering Corporation for the foundations of the new dam being constructed for the United Missouri River Power Company at Hauser Lake, near Helena. This work consists in replacing the dam which was destroyed last April. The borings for the foundations of the new structure have been sunk 16 ft. into solid rock and have established the presence of a solid and very hard flinty rock ledge at an average depth of 55 ft. below the normal water level. There are no very deep holes such as were generally feared, and, as the work is being done by the contractors on the "cost plus" basis, it is expected that the cost will be below the original estimate. The precise type of dam to be built will not be decided until further borings have been made, but 2,000,000 cu. ft. of timber for the cofferdam and 100,000 barrels of cement for the dam proper have been ordered. Since the contract was closed the construction camp has been practically completed with water supply and sanitary systems. An electric light plant is under construction and arc and incandescent lighting will be supplied for night work. The first move in the construction of the second large dam which is part of this project is in progress. This is the building of a spur from the line of the Montana Central Railroad to the site of the dam at Wolf Creek, 20 miles below Hauser Lake.

CUTLER-HAMMER COMPANY IN CONTROL OF NATIONAL BATTERY COMPANY.—Announcement is made by the National Battery Company, of Buffalo, that the receivership under which this company has been operating since last February was terminated Aug. 19. All claims against the National Battery Company have been settled, and the entire property has been restored to the stockholders. It is also stated that full control of the reorganized company has been secured by the Cutler-Hammer Manufacturing Company, of Milwaukee, well known as makers of battery charging rheostats and other electric controlling devices. The plant of the National Battery Company will remain at Buffalo, but the business will be conducted under new management and with ample capital .

PEREGRINA COMPANY'S TRACTION ROAD.—The Peregrina Mining & Milling Company, of Guanajuato, Mex., has purchased from the Westinghouse Electric & Manufacturing Company an electric locomotive which will be used to haul its ores between the mine and mill, a distance of about one mile. With this locomotive will be supplied a complete equipment, consisting of a motor generator set to convert the alternating current supplied by the Guanajuato Power & Electric Company to a direct-current switchboard and controlling apparatus. The company has declared the regular semi-annual dividend of 3½ per cent on the preferred stock.

Financial Intelligence.

THE WEEK IN WALL STREET.

Just what cause was responsible for the decline in stocks during the past week is a matter concerning which opinions differ. For more than a week, excepting only one slight recovery, the prices of stocks have been sagging. Well informed Wall Street men give different reasons for the slump. The advance in stocks which began in the spring and which has been persistent, excepting just enough temporary reactions to make it seem a natural market, has been the work of professionals. Strong financial interests, who realized last February and March that stocks were far too low as investments when compared with the lending value of money, began to accumulate heavy lines of securities. These purchases have been so continuous and so liberal that for months the scarcity of purchasable stocks at concessions from the market has caused comment. This scarcity has deterred the majority of the bears from attempting any strong campaign even when they realized that prices had risen much more rapidly than the advance toward normal conditions had progressed in commercial circles. The one reckless firm that attempted to produce a slump came to grief and found that it had sold in two hours more shares than it would be able to gather for regular delivery. The smali reactions have been brought about by profit taking, but they have been checked with ease. There has been, however, an expectation among conservative outsiders that as soon as the large operators had made a sufficiently strong market at an advanced level they would begin to sell. Men who purchased large blocks of Southern Pacific in the seventies, Union Pacific under 120, United States Steel, common, around 30, and Reading under 100, saw inviting profits when these stocks sold at 110, 165, 45 and 135, respectively. The men who make speculation in stocks their business do not buy securities for the pleasure of locking them up. They trade in stocks for the purpose of making profits. The question arises whether the market leaders have begun to unload? Many opinions are expressed on both sides of this question. If the large traders have sold out stocks are likely to go much lower, but if only the smallest speculators have disposed of their securities the reaction is temporary and when the market starts upward again it will be more firmly in hand than before. Some theorists say that a political scare is responsible for the slump. During the week Mr. James J. Hill left for the West, warning the Eastern Republicans of the danger of over-confidence, and Mr. E. H. Harriman returned from the West reporting that the Republicans were apathetic. There have been little definite views to encourage buyers of stocks. The annual railroad reports which are appearing show losses in gross revenue of from 10 to 20 per cent, the reports from iron and steel centers indicate a temporary halt in orders, and the fall buying by retail merchants is practically over. Crop and money conditions, however, are entirely satisfactory. On Monday, Sept. 21, the market continued its downward course more sharply than on any previous day of the movement. At the close of that day there had been pronounced losses since the close on the Monday previous. These ranged from 4 to 10 points among the leading issues. There were no gains to record. Money continued in plentiful supply. As the demand from the interior is lighter than usual at this season of the year it is met by the banks without inconvenience. The banks now suffer from a lack of borrowers for their burdensome excess of funds. On Sept. 21 call loans were quoted at 1 @ 1½ per cent, and 90-day paper was at 3 per cent. The quotations in the table are at the close Sept. 21.

NEW YORK.

	Sept. 14	Sept. 21	Shares Sold.		Sept. 14	Sept. 21	Shares Sold.
All.-Ch.	11	10¼	1,100	Int.-Met., pfd..	33½*	30	4,100
All.-Ch., pfd....	34	30½*	2,000	Mackay Cos. ...	69¼	68⅛*	250
Amal. Cop.	78¼	71¼	166,683	Mackay Cos., pfd.	70	69*	1,000
Am. D. T.....	35*	35*	——	Manhattan Elev.	139*	133¼	——
Am. Loc.	46¼	45	49,675	Met. St. Ry....	30*	30*	100
Am. Loc., pfd..	102¾	100¾	700	N.Y.&N.J. Tel..	117*	115½	411
Am. Tel. & Cbl.	70	68	40	Steel, com.	47	43¼	254,825
Am. T. & T....	129¼	126¾	11,450	Steel, pfd.	110⅜	107¾	26,720
B. R. T.....	52¾	47⅜	32,895	W. U. T.	61½	57⅜	4,035
Gen. Elec.	145	138	1,546	West'h. com. ...	74½	71	6,000
Int.-Met., com..	11¼*	10¾	2,821	West'h. pfd. ...	95*	88½	——

PHILADELPHIA.

	Sept. 14	Sept. 21	Shares Sold.		Sept. 14	Sept. 21	Shares Sold.
Am. Rys.	45*	44¾	——	Phila. Elec. ...	9⅞	9¼	——
Elec. Co. of A..	10	10⅛*	——	Phila. R. T....	20¾	17½	——
Elec. Stor. B'ty	38½	35¼	——	Phila. Traction.	88¼	88¼	——
E. S. B'ty, pfd.	49*	49*	——				

CHICAGO.

	Sept. 14	Sept. 21	Shares Sold.		Sept. 14	Sept. 21	Shares Sold.
Chi. City Ry...	176½*	176½*	——	Met. El., com..	16*	13¼	——
Com. Edison ..	107½	106½	——	Nat'nal Carbon.	72½*	70	——
Chi. Subway ...	20½*	20½*	——	Nat. Carb., pfd.	109¼	109¼	——
Chi. Tel. Co....	148	146	——				

BOSTON.

	Sept. 14	Sept. 21	Shares Sold.		Sept. 14	Sept. 21	Shares Sold.
Am. Tel. & Tel.	129½	127	——	Mass. E. R., pfd.	51	49	——
Comb'ind Tel...	125	125*	——	Mex. Tel., pfd..	6*	6*	——
Gen. Elec.	145	139⅞	——	N. E. Tel'p....	119	118½	——
Edison El. Ill..	235*	230	——	W. Tel. & Tel.	7½	7¼*	——
Mass. Elec. Ry.	9½	9¼	——	W. T. & T., pfd.	80	80*	——

*Last price quoted.
Shares sold are for week Sept. 14 to Sept. 19.

DIVIDENDS.

Providence (R. I.) Telephone Company, quarterly, 2 per cent, payable Oct. 1.

American Telephone & Telegraph Company, quarterly, 2 per cent, payable Oct. 15.

Bell Telephone Company of Canada, quarterly, 2 per cent, payable Oct. 15.

Otis Elevator Company, preferred, quarterly, 1½ per cent, payable Oct. 15.

Duluth (Minn.) Edison Electric Company, preferred, quarterly, 1½ per cent, payable Oct. 1.

Bangor (Me.) Railway & Electric Company, quarterly, 1¼ per cent, payable Oct. 1.

St. Joseph (Mo.) Railway, Light, Heat & Power Company, preferred, quarterly, 1¼ per cent, payable Oct. 1.

Colorado Telephone Company (Denver, Colo.), quarterly, 1¾ per cent, payable Oct. 15.

Peregrina Mining & Milling Company, Guanajuato, Mex., preferred, semi-annual, 3½ per cent.

Electric Boat Company, preferred, quarterly, 2 per cent, payable Oct. 1.

Manchester (N. H.) Traction, Light & Power Company, quarterly, 2 per cent, payable Oct. 15.

Union Switch & Signal Company (Pittsburg), preferred, quarterly, 3 per cent; common, quarterly, 3 per cent; payable Oct. 10.

Westinghouse Air Brake Company, quarterly, 2½ per cent, payable Oct. 10.

Chelsea Gas Light Company (Boston), quarterly, 2½ per cent, payable Sept. 30.

Massachusetts Lighting Companies, quarterly, 1½ per cent, payable Oct. 15.

Narragansett Electric Lighting Company (Providence, R. I.), quarterly, 2 per cent, payable Oct. 1.

Washington Water Power Company (Spokane, Wash.), quarterly, 1¾ per cent, payable Oct. 1.

American Cities Railway & Light Company, preferred, quarterly, 1½ per cent., payable Oct. 1.

Tri-City Railway & Light Company (Davenport, Iowa), quarterly, 1½ per cent, payable Oct. 1.

PHILADELPHIA RAPID TRANSIT FINANCING.—The new plan devised by the Philadelphia Rapid Transit Company for issuing $5,000,000 of 48-year 4-per cent bond embraces some novel features. The plan is to transfer to the Union Traction Company the Rapid Transit company's equity in the Market Street elevated road, receiving therefor permission to use certain securities. These will then be pledged as collateral security for the bonds. This indirect plan is explained by the directors this way: "The elevated line has cost $20,000,000 Of this sum $10,000,000 was raised by the issue of 4 per cent 50-year bonds, dated May 1, 1905, and the other half by the issue of stock, all of which is owned and held by the transit company. In the present state of the money market it would be difficult to place advantageously another mortgage upon the elevated, in view of the bond issue. The line is a valuable piece of property and is looked upon as ample security for the use of other collateral." The securities in question are now held by the Rapid Transit company, but, in accordance with the terms of the contract with the Union Traction Company, the securities cannot be used except by the express consent of the Union company's stockholders. A meeting of these stockholders has been called for the purpose of granting such consent. The securities are: All the stock of the Philadelphia & Willow Grove Street Railway, the Lehigh Avenue Passenger Railway, the Twenty-second Street & Allegheny Avenue Railway Company, against which there is no bonded indebtedness; as lessee of the Continental Passenger Railway, it owns all the stock of the Seventeenth & Nineteenth Streets Railway, one-half of the stock of the Empire Passenger Railway and of the Twelfth & Sixteenth Streets line, and the other half of these two outright; one-half the stock of the West Philadelphia Passenger Railway and one-fourth of the old Union Passenger Railway. The securities are valued at about $10,000,000 at the present market price. The fact that the Rapid Transit company's contract with the city of Philadelphia expires July 1, 1957, and that the city has a right to purchase at that time made it advisable to fix the term of the bonds at 48 years.

BOSTON ELEVATED SEEKS MORE STOCK.—It is announced that the directors of the Boston Elevated Railway Company will make application soon to the Massachusetts Railroad Commission for permission to issue $8,000,000 additional capital stock. The price at which this new stock shall be offered to the shareholders will be fixed by the commission. Permission to issue this stock was requested of the railroad commission last year, when authority was sought and secured to issue $5,800,000 bonds. The petition for the issue of stock was subsequently withdrawn. No new issue of stock has been made by the company since August, 1902, all of the financing of the road having been done through the issue of 4 per cent bonds. The plans for the new Cambridge subway have been approved and construction will be begun soon. This subway will be owned by the Boston Elevated Company, while the present subways are owned by the city and leased to the company. At the present time the Boston Elevated Railway is paying over $250,000 annually to the city for subway rental, and this amount will be augmented by over $300,000 next January when the new Washington Street subway is opened to traffic. The rental for the new tunnel is 4½ per cent of the total cost, which will be between $6,500,000 and $8,000,000.

MORE MASSACHUSETTS ELECTRIC COMPANIES' SECURITIES.—The Massachusetts Railroad Commission has been asked by the Old Colony Street Railway to approve the issue of $1,250,000 additional preferred stock. The Boston & Northern Street Railway has asked for permission to issue $750,000 additional preferred stock. Both of the concerns are subsidiaries of the Massachusetts Electric Companies. The stock is to be issued in each instance at $110 per share. The operating companies of the Massachusetts Electric Companies have a floating debt of about $3,500,000, incurred in construction and rehabilitation work. About $1,800,000 of this is held by the public, while the rest is held within the system. The sale of all or a portion of the constituent companies' preferred stock will make possible the retirement of all or nearly all of the floating obligations held by the outside public.

RECEIVER FOR SECOND AVENUE RAILROAD.—Justice Bischoff, of the Supreme Court of New York City, has appointed Mr. George W. Linch a temporary receiver for the Second Avenue Railroad Company, of New York. The bond was fixed at $100,000. The receiver was appointed in a suit brought by the Guaranty Trust Company, of New York, to foreclose a mortgage, securing bonds on which the interest had been defaulted. The road is a part of the Metropolitan Street Railway system.

NEW DENVER CITY TRAMWAY BONDS.—The stockholders of the Denver City Tramways Company have authorized an issue of $25,000,000 5 per cent first and refunding mortgage bonds. Of this new issue $13,000,000 bonds are to be set aside in retiring outstanding issues, and $12,000,000 are to be issued for new lines and extensions. These bonds shall be issued only in such amounts as represent the actual cost of improvements and in no case shall bonds be issued unless the net earnings of the company are at least 150 per cent of the fixed charges.

MASSACHUSETTS LIGHTING COMPANIES' EARNINGS.—The consolidated report of the subsidiary companies of the Massachusetts Lighting Companies shows that the total gross earnings for the year ended June 30, 1908, were $463,281, an increase of $60,486, while the net earnings were $166,785, an increase of $19,930. In addition to this showing it is stated that the company has spent about $150,000 during the year for permanent improvements and additions which will increase the earning power.

WESTINGHOUSE REORGANIZATION PLANS.—A meeting of the Readjustment Committee of the Westinghouse Electric & Manufacturing Company was called for Sept. 23, to hear the reports of the various sub-committees which have been soliciting subscriptions for the new assenting stock. Members of the readjustment committee and others identified with the reorganization plans express great confidence in the success of the scheme.

CHICAGO TELEPHONE BONDS SOLD.—The new issue of $5,000,000 of 5 per cent first mortgage bonds of the Chicago Telephone Company has been sold to the First Trust & Savings Bank and the Merchants' Loan & Trust Company, of Chicago, and Lee, Higginson & Company, of Boston, forming a syndicate which was the highest bidder, $991.44 per $1,000 bonds. A meeting of the stockholders will be held Oct. 7 to ratify the award.

RECEIVER FOR PHILADELPHIA, BRISTOL & TRENTON RAILWAY.—Judge Holland, of the United States Circuit Court at Philadelphia, has appointed John A. Rigg and George Blackstone receivers for the Philadelphia, Bristol & Trenton Street Railway Company. The action was taken on petition of the Interstate Railways Company and the United Power & Transportation Company. The company admitted its inability to pay the interest on its bonds.

AMERICAN RAILWAYS COMPANY SHOWS INCREASES.—The annual report of the American Railways Company for the fiscal year ended June 30, 1908, shows gross earnings of $2,927,436 for the subsidiary companies, which was an increase of $72,116 from the previous year. The total number of passengers carried was 68,762,586, an increase of 1.66 per cent. In speaking of the condition of the properties, Mr. Jeremiah J. Sullivan, the president of the company, says: "Late in the fiscal year the company's management succeeded in effecting a substantial reduction in the wages of many of its employees and reduced the working force to correspond with the reduction in the receipts." Mr. Sullivan also mentioned some features of the general recession which have produced satisfactory re-

sults, at least from the viewpoint of railroad corporations. One of these, explained Mr. Sullivan, lies in the fact that the managements have been enabled to obtained better service, because of the plentiful supply of competent workmen, dispensing with the less efficient employees and filling the vacancies with more competent men. Mr. Sullivan mentions as another result of the depression a substantial reduction in the prices of electrical apparatus and machinery and lumber.

NORTHWESTERN ELEVATED'S NEW FINANCIAL PLANS.—Unless something definite is done within the next two months looking to the consolidation of all the elevated railway lines in Chicago, the Northwestern Elevated Railroad Company will undertake financial reorganization on its own behalf. This announcement is made by Mr. John J. Mitchell, president of the Illinois Trust & Savings Bank, who is one of the voting trustees of the road. The plan provides for refunding the first mortgage bonds maturing Sept. 1, 1911. The new issue will be made large enough to take care of future development of the property. The Northwestern company has nearly $19,000,000 of bonds outstanding. Some of the treasury bonds are held as security for loans, the proceeds of which were used to complete extensions. As the readjustment of the company will probably include the issue of new capital stock as well as bonds, it is believed that the contemplated action may hasten the consolidation of the elevated lines. For the fiscal year ended June 30, 1907, the Northwestern company earned 5 per cent on its $5,000,000 preferred and 1.95 per cent on its $5,000,000 common stock.

ELECTRIFICATION INCREASES TRAFFIC.—A prominent official of the Grand Trunk Railway is quoted as saying that the new electrical equipment of the tunnel under the St. Clair River, between Sarnia and Port Huron, the installation of which was recently completed by the Westinghouse Electric & Manufacturing Company, has resulted in an increase in the traffic capacity at that point of more than one-third. The locomotives are of the single-phase type, five of them being now in operation, and two more are to be installed shortly. All passenger and freight trains have been hauled through this tunnel by these locomotives since May 17, 1908, having entirely replaced the steam locomotives. The tunnel, including the approaches, is two miles long.

HUDSON RIVER ELECTRIC POWER COMPANY BONDS.—The bondholders' protective committee of the Hudson River Electric Power Company has warned small holders of bonds not to sell at the prevailing market prices—from 40 to 50. As it is expected that these bonds will be worth more, the holders are urged to be slow about sacrificing their investments. The company was financed entirely through bond issues, and the fixed charges began to accrue before the property was in a position to meet them. Altogether about $11,000,000 in bonds have been issued by the parent company and its seven subsidiaries. The interest defaulted Aug. 1 was on $4,222,000. The earnings have shown a healthy growth within the year.

GENERAL ELECTRIC MAKES GOOD SHOWING.—While the General Electric Company is operating at the present time at about 60 per cent of its capacity, it will close the fiscal year ending Jan. 31, 1909, according to present expectations, with a creditable surplus after paying the regular dividends. The orders received by the company for the first six months of its year aggregated only $19,657,807, as compared with $35,096,117 for the corresponding period of 1907. The fact that the General Electric Company has been showing a surplus above dividend requirements is interesting, in view of the fact that the company showed net profits equal to only 10.11 per cent on its stock in the fiscal year ended Jan. 31, 1908.

REPORTS OF EARNINGS.

	Gross earnings.	Operating expenses.	Net earnings.	Charges.	Surplus.
United Railways Company, St. Louis:					
August, 1908	$911,515	$572,879	$338,636	$234,551	$104,085
August, 1907	956,240	610,160	346,080	232,506	113,574
Montreal Street Railway Company:					
August, 1908	$329,772	$164,262	$165,510	$70,077	$95,432
August, 1907	329,755	184,844	144,911	67,208	77,703
Jamestown (N. Y.) Street Railway Company:					
April 1 to June 30, 1908	$27,821	$24,472	$3,349	$15,042	*$11,238
April 1 to June 30, 1907	27,063	20,733	6,330	7,115	*279
Cumberland Telephone & Telegraph Company:					
August, 1908	$489,511	$287,636	$201,875	$37,724	$164,151
August, 1907	486,265	307,110	179,155	37,887	141,267
Elmira (N. Y.) Water, Light & Railroad Company:					
April 1 to June 30, 1908	$58,117	$42,222	$15,895	$15,589	$3,220
April 1 to June 30, 1907	55,606	42,161	13,445	13,523	1,992
Elmira (N. Y.) & Seneca Lake Traction Company:					
April 1 to June 30, 1908	$14,866	$11,884	$2,982	$3,985	*$947
April 1 to June 30, 1907	14,497	10,098	4,399	2,296	2,170
Lynn (Mass.) Gas & Electric Company:					
Year ended June 30, 1908	$854,762	$550,846	$303,916	$80,500	$223,416
Year ended June 30, 1907	792,309	495,306	297,003	80,500	216,503
Waltham (Mass.) Gas Company:					
Year ended June 30, 1908	$208,345	$148,550	$59,795	$32,470	$27,325
Year ended June 30, 1907	183,194	132,582	50,612	32,470	18,142
Massachusetts Lighting Companies:					
Year ended June 30, 1908	$463,281	$296,496	$166,785	.....	.....
Year ended June 30, 1907	402,794	255,940	146,840	.....	.....
Philadelphia Rapid Transit Company:					
Year ended June 30, 1908	$18,300,080	$9,794,508	$8,505,572	$7,460,916	*$92,049
Year ended June 30, 1907	18,095,503	10,095,098	8,000,405	7,488,958	*364,048
American Railways Company:					
Year ended June 30, 1908	$498,757	$171,645	$327,112	$305,706	$21,406
Year ended June 30, 1907	527,062	142,503	384,558	304,392	80,166
Lowell Electric Light Corporation:					
Year ended June 30, 1908	$331,269	$220,530	$110,739	$74,400	$36,339
Year ended June 30, 1907	292,850	183,090	109,750	63,164	46,586
Edison Electric Illuminating Company, Brockton, Mass.:					
Year ended June 30, 1908	$208,180	$124,731	$83,449	$34,250	$49,199
Year ended June 30, 1907	178,547	111,444	67,103	12,500	54,603
American Telephone & Telegraph Company:					
August, 1908	$2,089,133	$151,334	$1,937,799	$614,253	$1,323,545
August, 1907	1,682,937	174,218	1,508,719	594,149	914,570
Philadelphia Company (Pittsburg):					
March 1 to July 31, 1908	$5,339,143	$3,103,404	$2,235,689	.....	$610,168
March 1 to July 31, 1907	6,423,337	4,175,581	2,247,756	.....	712,731

*Deficit.

GENERAL NEWS

Construction News.

DAWSON, ALASKA.—The Yukon Basin Gold Dredging Company is preparing plans for the construction of a hydro-electric plant at Fraser Falls, in the Yukon River, to generate electricity to operate a fleet of dredges on the Stewart River. G. W. Clawson is secretary and manager.

WICKENBURG, ARIZ.—The Central Arizona Electric Company has been organized for the purpose of installing an electric light and power plant at the mines of the Octave Mining Company. The contract for machinery for the plant has been awarded.

WILLIAMS, ARIZ.—The City Council has passed an ordinance granting the Grand Canyon Electric Light & Power Company a franchise to construct a system of water works and sewerage system and an electric light and power plant in this town.

FAYETTEVILLE, ARK.—A movement is on foot to construct an electric railway in Fayetteville with branches to Huntsville and Siloam Springs. J. R. Ahlefeld, of Leroy, Kan., is interested in the project.

BAKERSFIELD, CAL.—The Board of Supervisors has granted a franchise to J. C. Danner to construct a telephone line from Isabelle to Weldon along the county road.

BURLINGAME, CAL.—Application has been made to the City Trustees by H. W. Hagen for a franchise to construct an electric railway along East Lane, thence down Howard Avenue to the beach.

DEDRICK, CAL.—Plans are being made to install a power plant to operate a stamp mill in connection with the Chloride, Bailey and Globe mines. W. D. Pinkston is principal owner.

LIVE OAK, CAL.—A new company is being formed which will be known as the Live Oak & Encinal Lighting Corporation by the business men of Live Oak. The company proposes to erect transmission lines from the substation at Encinal along the public road to Live Oak and place the lamps on the poles of the Bay Counties Power Company. For further information address B. M. Sweeney.

OAKLAND, CAL.—Plans have been completed by Walter J. Matthews for the new Federal immigration station on Angel Island. All the buildings are to be entirely new and will include a power house, which will be equipped with a 100-hp engine and a generator of 75 kw. The plant will furnish electricity for lighting the whole station.

OROVILLE, CAL.—Notice of appropriation of 25,000 in. of water of the Middle Fork of the Feather River has been filed by H. O. League. It is proposed to develop the water power to generate electricity.

RED BLUFF, CAL.—The City Trustees have granted the Northern Electric Company a franchise for the extension of its electric railway through the main street of the city.

RICHMOND, CAL.—The Santa Fe Railroad Company has completed its electric plant, which will furnish electricity for lighting its building and yards in Richmond. The cost of the plant is estimated at $20,000.

ROSEVILLE, CAL.—The Southern Pacific is installing an electric plant to furnish electricity to light its buildings and yards and also to operate the machinery in its machine shops located at Roseville.

SAN DIEGO, CAL.—The Benson Lumber Company is planning to install an electric plant, work on which will begin about the first of next year. O. J. Evenson is local manager.

SAN FRANCISCO, CAL.—The Permanent Downtown Association has awarded a contract to Thomas Day & Company to furnish 169 lamps to be placed in the downtown district.

SAN RAFAEL, CAL.—Mr. Felton, of the Snow Mountain Water & Power Company, states that it is their intention to bring the water from Gravely Valley, through a tunnel into Potter Valley, thence down below Cloverdale, at which place they would take water out for irrigation purposes only. It is proposed to establish a power plant at the mouth of the tunnel in Potter Valley.

UKIAH, CAL.—It is reported that arrangements have been made between the Snow Mountain Water & Power Company and the Bay Counties Light & Power Company whereby the transmission lines of the companies will be connected near Santa Rosa, Cal. As soon as the connection is made the Snow Mountain Water & Power Company will close down its plant to make needed repairs to the tunnel and pipe line.

DENVER, COL.—It is reported that plans are being made to equip the new Denver, Laramie & Northwestern Railroad to be operated by electricity as soon as the road from Denver to Fort Collins is completed. If the electric service is satisfactory electrical power will be substituted all the way to Laramie.

DENVER, COL.—The stockholders of the Northern Colorado Power Company on Sept. 5 voted to issue $6,000,000 in bonds, half of which will be used to retire present outstanding bonds amounting to $3,000,000 and the proceeds of the other half will be used to provide funds for extending the transmission lines of the company in the northern part of the State.

TORRINGTON, CONN.—It is reported that arrangements have been completed by the Litchfield & Torrington Tramway Company for the construction of the proposed electric railway which is to connect Litchfield and Torrington, a distance of six miles.

WASHINGTON, D. C.—Bids will be received until Oct. 17 by H. L. Pettus, constructing quartermaster, Takoma Substation, Washington, D. C., for furnishing and installing combination gas and electric fixtures at the Walter Reed Army General Hospital.

WASHINGTON, D. C.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until Sept. 29 to furnish at the navy yard, Mare Island, Cal., a quantity of supplies as follows: Schedule 271—Furnishing and installing engine, generator and switchboard. Schedule 309—Iron, copper tubing, etc. Application for proposals should designate the schedules desired by number. Blank proposals will be furnished upon application to the above bureau or to the navy pay office, San Francisco, Cal. E. B. Rogers is paymaster general, U. S. N.

WASHINGTON, D. C.—Bids will be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until Sept. 29, for furnishing at the various navy yards and naval stations the following supplies: Mare Island, Cal., Schedule 284—680 lb. seamless drawn copper tubing, etc.; Schedule 309—Seamless drawn copper tubing, etc.; Brooklyn, N. Y., Schedule 317—Three constant-current regulating transformers; also until Oct. 6 as follows: Schedule 336—Commercial brass rod, 2200 lb. rolled bronze, 21,600 lb. seamless drawn brass pipe, service and lock cocks; also until Oct. 13 as follows: Mare Island, Cal., Schedule 335—Motor-driven lathe, etc. Applications for proposals should designate the schedule desired by number. E. B. Rogers is paymaster-general, U. S. N.

MIAMI, FLA.—The Florida East Coast Hotel Company is preparing to extend its electric light service to Lemon City, and may later extend its transmission lines to Cocoanut Grove to furnish electricity for commercial and street lighting.

PHENIX, ALA.—The Phenix-Girard Power & Lighting Company has applied to the City Council for a franchise to establish an electric plant to furnish electricity for lamps and motors for Phenix and Girard. T. W. Butts and B. A. Bass, of Columbus, and I. I. Moses and D. C. Foster, of Girard, are interested in the enterprise.

WAYCROSS, GA.—The Atlantic Coast Line Railroad Company has decided to adopt electricity for lighting its shops and yards in Waycross, and also in other places. Orders have been placed for lamps for 400 switches for 75 2000-cp arc lamps.

EMMETT, IDAHO.—The Idaho-Oregon Light & Power Company, which owns the Emmett lighting plant and the Ox Bow power plant and several other plants in the Payette Valley, will soon begin work on the construction of a substation in this city. The building will be located at the eastern terminus of Main Street and electrical energy will be distributed from this station for several plants of the company.

CHANDLERVILLE, ILL.—The Village Board is advertising for bids for the equipment of a municipal electric light plant to include a 50-hp gas producer engine with a 75-hp producer, or a 50-hp steam engine and generator.

CHICAGO, ILL.—Plans are being considered by the Illinois Central Railroad Company to change the motive power for operating its trains in the Chicago terminal from steam to electricity. James T. Harahan is president of the company.

CHICAGO, ILL.—Bids will be received by the City of Chicago, Ill., until Sept. 26 at Room 705 City Hall, for material and construction of the steam and exhaust lines to the electric engines at the Lawrence Avenue pumping stations, according to plans and specifications on file at the office of the Department of Public Works, Room 806, City Hall. John J. Hanberg is commissioner of public works.

MONMOUTH, ILL.—Contracts have been awarded by the Rock Island Southern Railroad Company as follows: To the Rock Island Construction Company, for construction of its railway from Galesburg or Monmouth to Aledo; from Preemption, Ill., to Aledo Junction, to the Walsh Construction Company, of Davenport, Ia. Arrangements have been made for the use of the Chicago, Rock Island & Pacific Railroad Company's tracks from Rock Island to Reynolds for a term of 25 years. It is understood that the steam section of the company's system will be equipped to be operated by electricity at once.

OREGON, ILL.—The plant of the Oregon Electric Light & Power Company is reported to have been destroyed by fire. The plant furnished electricity for lighting the streets of the city, which will be in darkness for the present. The company also furnished electrical energy for the piano factory and other local industrial concerns.

COAL CITY, IND.—A number of local and Indianapolis capitalists, headed by Warren Meek, of this city, have purchased 600 acres of land, including the Steiner land or the Cataract Falls in Eel River, near Coal City. The plan is to construct a dam 50 ft. high, at a cost of $150,000, just above the lower falls. A power house will be erected at the lower

falls and a large electric plant will be established to furnish electricity to light all the towns in this part of the State, as well as the coal mines.

EVANSVILLE, IND.—A. L. Swanson, of Evansville, Ind., has been awarded the contract for the construction of the Furniture Exchange Building, which includes engines, generators and complete wiring system.

GOSHEN, IND.—The City Council has authorized Mayor Kohler to contract with Robert N. Ashe, of Richmond, Ind., to install a new lighting plant in Goshen for arc and commercial lighting, at a contract price of $39,857 in rentals, the last payment to be made July 15, 1919. After a payment on top of that of $3,587 the plant belongs to the city. The people are now taking steps to enjoin the carrying out of the contract, alleging that the rental method of payment is a subterfuge to get around the constitutional limit of indebtedness.

HUNTINGBURG, IND.—The Ferdinand Electric Railway Company has been granted a franchise to enter Huntingburg, and will soon commence work on the construction of an electric railway from Huntingburg to Ferdinand. The road will be seven miles in length.

SHELBYVILLE, IND.—The County Commissioners are considering the question of installing an electric plant in the basement of the county jail to furnish electricity for lighting the county buildings.

DES MOINES, IA.—The Des Moines Edison Light Company has notified the City Council that it would accept the ordinance passed in April, 1908, reducing the rate for street arc lamps in the downtown section of the city served by underground conduits, from $95 to $75 per lamp per year. Plans are now being made by the company for extensive improvements to its plant, which will include the rewiring of the entire downtown section of the city with cable and the installation of new boilers in its power house and other improvements, the cost of which is estimated at about $60,000.

McPHERSON, KAN.—The City Council is considering the question of establishing a municipal electric lighting plant and water works system. It is proposed either to buy the present system or install an entirely new plant.

GREENVILLE, KY.—The Greenville Light & Water Company has decided to issue $12,000 in bonds, the proceeds to be used to extend its transmission lines, water mains, etc.

LOUISVILLE, KY.—The Louisville & Eastern Railroad Company is reported to have completed negotiations for a loan of $400,000, the proceeds of which will be used to complete the extension to Shelbyville and to make other necessary improvements. Percival Moore, of Louisville, is general manager.

LEWISTON, MAINE.—Announcement has been made that the New England Telephone & Telegraph Company has obtained control of the Northeastern Telephone Company, the Lewiston-Auburn Company and the Cumberland Company, three independent companies operating in about 25 cities and towns in the State of Maine.

AMHERST, MASS.—The Amherst Gas Company has applied to the Selectmen for permission to erect a transmission line on the Belchertown Road to Kellogville.

BOSTON, MASS.—The Edison Electric Illuminating Company has entered into a contract with the Hide-ite Leather Company for furnishing electricity to operate its leather board factory on Ames Street when completed. The Edison company is to supply 230 hp to operate and light the factory.

BOSTON, MASS.—Bids will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until Oct. 10, for furnishing and installing two boilers, with stokers, superheaters and stack at the navy yard, Boston, Mass. Plans and specifications can be obtained on application to the bureau or to the commandant of the navy yard named. William M. Smith is acting chief of bureau.

GARDNER, MASS.—The Selectmen have made a new arrangement with the Gardner Electric Light Company whereby the electric street lamps are to burn all night instead of until midnight as in the past.

HINSDALE, MASS.—Samuel Hauben, owner of the hotel property, contemplates the installation of an electric light plant to furnish electricity for lighting the hotel and stable. It is probable that, if the plant is erected, Mr. Hauben will apply to the town for a franchise to furnish electricity for lamps to the citizens in Hinsdale.

LEOMINSTER, MASS.—An electric light plant is being installed at Fort Pond for Arthur C. Merriman, to furnish electricity to light the grounds of the estate.

NEWBURYPORT, MASS.—Burley & Stevens are installing an electric light plant to furnish electricity for lighting their shoe factory.

NORTH ATTLEBORO, MASS.—Announcement has been made of a new schedule of rates for electricity for motors by William Plattner, manager of the municipal electric light plant. The new rates are to take effect from Sept. 1, under which the minimum charge for motors is reduced from $1.50 and $1.25 to $1 per month per horse-power on all sizes of electric motors.

SHELBURNE FALLS, MASS.—The Shelburne Falls Electric Light & Power Company has awarded the contract for the construction of its new power house, engine room and coal pockets to H. C. Woods & Company, of Westfield, Mass.

TURNERS FALLS, MASS.—At a special town meeting held Sept. 9 the citizens voted to adopt the report of the special committee appointed to investigate the question of lighting the streets of the town. The prudential committee was authorized to enter into a contract with the Franklin Electric Light Company to furnish 76 tungsten lamps of 60 cp at $24 per lamp per year and 16 arc lamps at $82.50 each per year. Under the present contract the town pays $87.50 each for 45 arc lamps and $25 each for five incandescent lamps, making a total of $4,062.50 per year.

ERHARD, MINN.—The Erhard Telephone Company is planning to erect 12 miles of new telephone lines this fall.

EYOTA, MINN.—It is reported that the Village of Eyota is receiving bids for the construction of an electric light plant. J. L. Ebling is village recorder.

LUCEDALE, MISS.—The Allis-Chalmers Company, of Milwaukee, Wis., has secured the contract for the electrical installation for the plant of the Lucedale Light & Power Company. J. A. Holifield, of Mobile, Ala., was awarded the contract for the distributing system for the mill and town, the work to be completed by Oct. 15. The plant will have an output sufficient to supply electricity for 1000 lamps.

CHILLICOTHE, MO.—The People's Telephone Company contemplates remodeling its telephone system in Chillicothe and also extending the system.

CLAYTON, MO.—The Clayton Electric Company will soon apply to the county court for a franchise to supply electricity in St. Louis County. It is said that the company proposes to erect a plant and furnish electricity at a much less rate than is now being paid for electric service in this city.

GARDEN CITY, MO.—Plans are being prepared for the proposed power plant to be constructed by the Kansas-Colorado Electrical Transmission Company in Garden City. The plans call for a building 130x160 ft. in size, in which will be placed three units of 3750 kw each.

JOPLIN, MO.—Contracts have been awarded by the Consolidated Light, Power & Ice Company for equipment for its proposed new power plant. The cost of the plant is estimated at $200,000 and will have an output of 2000 hp. George Moore is president of the company.

KANSAS CITY, MO.—The City Council is considering plans for ornamental lamps for the business streets of the city, for which contracts will soon be let. According to the present plans, the business men will pay for the brackets, the city is to pay for the electricity, the electric light company to supply globes and burners, and the street railway company to give the use of its poles.

KANSAS CITY, MO.—The Kansas City & Olathe Electric Railway Company has completed its new electric railway from the terminus of the Metropolitan line in Rosedale to Shawnee, a distance of five miles, and it is stated that the road will be extended from Shawnee to Lawrence in a few months. The railway as originally planned is to extend to Olathe. Electricity for operating the system is furnished by the new power plant located at Merriam, Kan. Frank P. Dickson is president of the company.

SPRINGFIELD, MO.—Plans are being prepared for the installation of a new central heating and lighting plant for heating and lighting the Drury College buildings and also to supply electricity for lighting the campus. The cost of the plant is estimated at $20,000. Dr. George Baldwin is president of the college.

ST. JOSEPH, MO.—The City Council has voted to issue $15,000 in bonds, the proceeds to be used to improve the lighting system on 30 blocks in the city. The city is to pay for the conduits and cables and the property owners are to buy and maintain the ornamental lamps.

GLASGOW, MONT.—The contract for the construction of the municipal electric light works has been awarded to W. D. Lovell & Company, of Minneapolis, Minn., for $13,500.

MISSOULA, MONT.—Messrs. Costello & Weisberger, of Spokane, Wash., have applied to the City Council for permission to operate a street railway system in the City of Missoula.

CLARKSON, NEB.—The contract for the construction of the municipal electric light plant is reported to have been awarded to J. P. Brown, of Fremont, Neb.

FALLS CITY, NEB.—The new equipment for the municipal electric lighting plant has arrived and will be installed as soon as the new power house is completed.

GOLCONDA, NEV.—The Golconda Telephone & Power Company has applied to the County Commissioners for a franchise to erect a plant in Gold Run Township.

GOLDFIELD, NEV.—Plans are being considered for the construction of an electric railway system in Goldfield. The railway will be about five and one-half miles in length and will cost about $125,000. George Wingfied, D. Sullivan, T. F. Manning and Senator H. V. Morehouse are interested in the enterprise.

RENO, NEV.—James A. Maguire, an attorney of San Francisco, has awakened considerable interest in Nevada by the publication of a pamphlet in which he describes a large undertaking said now to be on foot to take water from the Truckee River, near Lake Tahoe, and convey it to the cities around San Francisco Bay. The plan is to divert the water near where it flows out of Lake Tahoe and by means of tunnels and canals convey it through the backbone of the Sierras to the American River. It is to be used several times for the development of electric power before it finally goes into pipes to be conveyed to San Francisco.

HOBOKEN, N. J.—Plans are being prepared for equipping the Delaware, Lackawanna & Western Railroad Company's system from Hoboken

to Morristown, N. J., to be operated by electricity, work on which, it is reported, will begin soon after the first of January. According to the present plans, it is proposed to change the motive power on 32 miles of the road, and the actual work will begin as soon as the new tunnel through Bergen Hill is completed. It is expected that the Montclair branch of the road will be changed from steam to electricity during the year 1910.

NEWARK, N. J.—Proposals will be received by the public buildings committee of the Essex County Board of Chosen Freeholders, at the Essex County Court House, Newark, N. J., until Sept. 28, for the installation of electrical and heating systems at the Essex County Hospital for the Insane, Overbrook, N. J. Plans and specifications may be seen at the office of Hurd & Sutton, architects, Union Building, Newark, N. J., where copies of the specifications and blank forms of proposals may be obtained. Copies of the plans and specifications of the electrical work may be seen at the office of Runyon & Carey, consulting engineers, 22 Market Street, Newark, N. J. Emmett J. Quinn is acting chairman of public buildings committee.

AUBURN, N. Y.—The City Council has renewed the contract for street lighting with the Auburn Light, Heat & Power Company to take effect from Oct. 1. The new contract calls for an all-night service instead of until 1 p. m. as under the present contract.

BUFFALO, N. Y.—The Niagara Falls Power Company has made arrangements with the Buffalo & Lake Erie Traction Company whereby the transmission lines of the traction company will be utilized by the power company for the transmission of electricity for lamps and motors in Fredonia, N. Y.

BUFFALO, N. Y.—The Niagara, Lockport & Ontario Power Company has been awarded the contract for furnishing electricity for operating the new limestone quarry to be opened near Sanborn, N. Y., by the Casper Limestone Company, of Columbus, Ohio, and the Empire Limestone Company, of Buffalo, N. Y. The company will erect a transmission line nine miles in length to the substation to be owned and operated by the quarry company. The equipment of the station will include three 200-kw oil-cooled transformers, three 190-kw oil-cooled transformers, one 500-kw rotary converter, together with switchboard apparatus and accessories complete. The crushers will be driven by a 250-hp motor, two motor-driven air compressors, 40-hp motor-driven conveyor; the power shovel to be equipped with four 75-hp motors. It is understood that equipment of the plant will be furnished by the Allis-Chalmers Company, of Milwaukee, Wis. Work on the construction of the plant will commence at once.

CANANDAIGUA, N. Y.—Bids will be received by J. Foster Warner, Granite Building, Rochester, architect (addressed to R. M. Simmons, chairman special building committee), for electric wiring, for lighting and power, also fixtures, etc., for the court house at Canandaigua, N. Y.

ELMIRA, N. Y.—The American Salesbook Company has awarded the contract for the installation of the electric lighting and power system for its new plant, now under construction, to C. H. Young, of Elmira, N. Y.

NEW YORK, N. Y.—Plans are being considered for important extensions to the systems of the Third Avenue Railroad and the Union Railway Companies by Frederick W. Whitridge, receiver, provided that franchises can be obtained from the city which are satisfactory to the Central Trust Company, trustee, and the bondholders' committee of the Third Avenue Railroad Company. The receiver proposes to run the Third Avenue Railway cars to Brooklyn and Long Island City, and to build a railway from Third Avenue, Manhattan, along Fifty-eighth Street and Sixtieth Street and over Blackwell's Island Bridge to Long Island City, and another extension from Canal Street and the Bowery across the new Manhattan Bridge. It is also proposed to extend the tracks of the Third Avenue system in Amsterdam Avenue along Fort George Avenue to St. Nicholas Avenue to 190th Street and easterly in 190th Street to Amsterdam Avenue. The plan for improvements to the system of the Union Railway Company includes an extension from Westchester Avenue in the Bronx along Clason Point Road to Clason Point; also from the present terminus of the Fordham line in Fordham, along Pelham Avenue to Southern Boulevard and the entrance to Bronx Park; a railway from the Fordham Landing Road in 207th Street to connect with the subway station at 207th Street and Eleventh Avenue, and with the Kingsbridge lines in Broadway, and also an extension in 230th Street from Bailey Avenue to Broadway.

NIAGARA FALLS, N. Y.—The Ontario Power Company has awarded the contract for the construction of an extension 100 ft. long to its power house to Harry D. Symmes, of Niagara Falls, N. Y. The extension will permit of the installation of two additional units of 12,500 hp each.

ONEONTA, N. Y.—Bids will be received by Henry D. McLaury, village clerk, until Oct. 20, for lighting the streets of the Village of Oneonta with electricity. Bids will be received for furnishing 100 arc lamps of 2000 cp to burn on all-night schedule on a three or a five year contract beginning March 1, 1909.

OXBOW, N. Y.—Plans are being considered by A. B. Clark and Pitt McAllister, of Oxbow, N. Y., for the construction of an electric light plant, surveys for which are now being made. It is proposed to bring a water supply to Oxbow to operate the plant. The plant will furnish electricity for residential and street lighting and for motors.

ROCHESTER, N. Y.—Arrangements are being made by the LaMay Machine Works to erect a large machine shop on the corner of McNaughton and Emerson Streets. The plant will include a large manufacturing building and power house and brass foundry. The company is considering installing an electric generating plant to be operated by steam power and equipping all large machines with individual motors and grouping smaller machines and operating them with a single motor.

ROCHESTER, N. Y.—Bids will be received by Willis K. Gillette, secretary, commissioners of public buildings, until Sept. 28 at the office of the purchasing agent in the court house for the following electrical supplies: 1,000 Edison lamps, 16 cp, 117 volts; 500 Edison lamps, 8 cp, 117 volts; 50 Edison lamps, 100 watt, 117 volts; 8 tungsten lamps, 100 watt, 117 volts; 10 tungsten lamps, 40 watt, 117 volts; 6 tubular shape lamps, 117 volts; 50 fuse plugs, 6 amp.; 25 fuse plugs, 10 amp.; 50 fuse plugs, 15 amp.; 50 cartridge, 6 amp.; 25 cartridge, 10 amp.; 25 cartridge, 15 amp.; 300 adapters; 12 rolls insulating tape; 6 rolls gum tape; 500 ft. fixture wire No. 18; 200 ft. reinforced lamp cord.

SYRACUSE, N. Y.—Bids will be received until Oct. 1 by Frank X. Wood, purchasing agent, for the construction of a power house at the Onondaga County Home, in Onondaga. The equipment of the plant will consist of three direct connected steam engine driven units, for which bids will be called for within 30 days.

TONAWANDA, N. Y.—Three 500-hp, motor-driven centrifugal pumps are now being installed by the city of Lockport on the banks of the Niagara River for the purpose of forcing water through a 36-in. pipe line from the Niagara River to Lockport, a distance of 12 miles. Electrical energy for operating the pumps will be supplied by the Tonawanda Power Company, of North Tonawanda, which is transmitted from Niagara Falls at a voltage of 22,000. F. M. Gordon is manager of the power company.

FAYETTEVILLE, N. C.—The Fayetteville Street Railway Company will use electricity instead of gasoline motors hereafter in the operation of its street railway system. Orders have been placed for poles, wiring, etc., for an overhead trolley system.

GASTONIA, N. C.—W. S. Lee and L. C. Harrison have been granted a franchise to operate an electric railway system in the town of Gastonia. It is said that the same parties propose to build an electric railway, 32 miles long, to connect King's Mountain and Mt. Holly. It is reported that parties representing the Charlotte Power Company will also ask the City Council of Charlotte, N. C., for a franchise to enter the city with an electric railway some time in October.

HICKORY, N. C.—The Horseford Power Company has changed its name to Weston Carolina Power Company and increased its capital stock from $125,000 to $300,000. Work on the construction of the plant, it is reported, will begin at once. J. D. Elliott is president.

MONROE, N. C.—The Southern Power Company has contracted with the city of Monroe and with the Henderson Roller Mills, Monroe Oil Mill, the Icemorlee and the Everett Cotton Mills, all in Monroe, to supply electricity, practically guaranteeing the building of transmission lines of 100,000 volts to Monroe.

THOMASVILLE, N. C.—The Thomasville Light & Power Company is negotiating with a number of local wood-working and furniture factories for the installation of electricity to take the place of steam power.

WAKE FOREST, N. C.—The Town Commissioners of Wake Forest have ordered an election to vote on the proposition to issue $10,000 in bonds to build an electric plant to furnish electricity to light the town and Wake Forest College.

BATHGATE, N. D.—The Citizens' Telephone Company is planning to make extensive improvements to its telephone system.

DAYTON, OHIO.—The County Commissioners have granted the Dayton Lighting Company permission to erect a pole line on Gettysburg Avenue to the Gettysburg Infirmary to furnish electricity to the new County Infirmary. The company is also allowed to furnish electricity to private consumers along the Eaton Pike and the infirmary road during the life of its contract with the County Infirmary.

GALLIPOLIS, OHIO.—Contracts have been awarded by Samuel Hanaford & Son, Cincinnati, Ohio, for a power plant for the Ohio Hospital for Epileptics, Gallipolis, as follows: To the Skinner Engine Company, for engine; to the Western Electric Company, of Cincinnati, for 125-kw generator, etc.; for switchboard, wiring, etc., to the E. Hopkins Company. Dr. W. H. Prichard is superintendent of the hospital.

JEFFERSON, OHIO.—A franchise has been granted by the Village Council to Charles Phelps and associates to construct and operate an electric light plant in Jefferson.

LIMA, OHIO.—The Western Ohio Railway Company is in the market for a 100-kw generator set. F. D. Carpenter is general manager.

LIMA, OHIO.—The plant of the E. W. Hiner Stone Company has been purchased by E. W. Hiner and T. N. Cunningham. The new company is planning to install a modern stone quarry plant, which will be operated by electricity.

McCONNELLSVILLE, OHIO.—The Zanesville & Meigs Valley Traction Company has applied to the Board of County Commissioners for a franchise to operate an electric railway on the highways in Morgan County. The company proposes to build an electric railway from Zanesville to Beverly, Ohio. L. H. D. Blodgett, of Zanesville, is general manager.

MT. VERNON, OHIO.—The contract for the electrical equipment of the Ohio State Sanatorium at Mt. Vernon, Ohio, has been awarded to the Electrical Supply & Construction Company, of Columbus, Ohio, for about $30,000. Mark Simonton is president and general manager of the Electric Supply & Construction Company.

NEWTON FALLS, OHIO.—Plans have been prepared by Roberts & Abbott, Schofield Building, Cleveland, Ohio, engineers, for two power houses to be built at Newton Falls for the Peerless Electric Company, of Warren.

SPRINGFIELD, OHIO.—Application has been made to the City Council by the Springfield & Washington Railway Company for a franchise to construct and operate a street and interurban railway within the city limits.

ANTLERS, OKLA.—The city is contemplating the construction of a municipal electric light plant, and has engaged an engineer to make estimates of the cost of the same.

WETUMKA, OKLA.—The O'Neill Engineering Company, of Dallas, Tex., has been awarded the contract for installing the electric lighting system.

COTTAGE GROVE, ORE.—A petition has been presented to the City Council asking that a 25-year franchise be granted to the Cottage Grove Electric Company for furnishing electricity for lamps and motors in this city.

HILLSBORO, ORE.—F. G. Sykes, general manager of the Portland Railway, Light & Power Company, has submitted a proposition to the City Council for the purchase of the municipal electric light and water plants. The price offered for the plants was $14,000. As the plants cost $40,000 and are considered to be in good condition it is not expected the offer will be considered.

PILOT ROCK, ORE.—Notice has been filed with the county recorder by Douglas Belts showing an appropriation of 30,000 in. of water per minute from the north fork of the John Day River to be utilized for generating electricity. It is understood that a company will soon be formed to construct an electric power plant for the purpose of transmission of electricity to Pilot Rock and Pendleton. It is said that A. R. Turner, of Ukiah, Ore., and George G. Schlegel, of Pilot Rock, Ore., will be associated with Mr. Belts in the proposed enterprise.

PANAMA.—Bids will be received at the office of the general purchasing officer, Isthmian Canal Commission, Washington, D. C., until Oct. 12 for furnishing hoisting engines, generator and engine, electrical supplies, wire, etc. Blanks and general information pertaining to this circular (No. 468) may be obtained at the above office or the offices of the assistant purchasing agents, 24 State Street, New York, N. Y.; Custom House, New Orleans, La.; and 1086 North Point Street, San Francisco, Cal. Captain F. C. Boggs is general purchasing officer.

CANONSBURG, PA.—Owing to water famine, the plant of the Canonsburg Electric Light, Heat & Power Company has been obliged to close down, leaving the streets of the town in total darkness.

CARBONDALE, PA.—Arrangements are being made by the Pennsylvania Telephone Company for the extension of its telephone line to this town, a franchise for which was recently granted by the Borough Council. E. F. Ritter, of Allentown, Pa., is district manager.

EMAUS, PA.—The Town Council has granted the Pennsylvania Telephone Company permission to build its telephone lines through the borough. The company proposes to install a local exchange.

MAHONING, PA.—The Mahoning Rural Telephone Company, recently organized, proposes to erect a telephone line from Tamaqua to Lehighton, a distance of 16 miles. A. W. Wertman is president.

PITTSBURG, PA.—Plans are being made for the power plant for heating, lighting and power purposes for the new applied science buildings of the Carnegie Technical School. The trustees have decided to use the Machinery Hall for a power house, in which new engines and machinery are being installed. The original plan of having the steam plant and boilers on the grade of the Baltimore & Ohio Railroad in Junction Hollow, in order to gain the advantage of direct coal supply from the cars, has been abandoned.

WILKESBARRE, PA.—The City Council has granted the Bell Telephone Company permission to place its wires in underground conduits in Wilkesbarre.

NEWBERRY, S. C.—It is reported that the Parr Shoals Power Company is making investigations with a view of commencing work on the construction of its proposed dam on the Broad River. W. S. Dowling, of New York, N. Y., and A. L. Scott, of Boston, Mass., are interested in the enterprise.

ABERDEEN, S. D.—F. V. Raymond, city auditor, writes that a franchise has been granted to the Aberdeen Light & Power Company to establish an electric light plant.

MITCHELL, S. D.—It is reported that the Mitchell Power Company will soon commence work on the construction of a new electric light and gas plant, which will be located about one-half mile from the present plant of the company. Entire new machinery will be purchased for the electric light plant, and a coal plant will take the place of the acetylene gas plant.

CHATTANOOGA, TENN.—The contract for the construction of the electric transmission lines from Hale's Bar to Chattanooga has been awarded by the Chattanooga-Tennessee Power Company to Guild & Company, of Chattanooga, Tenn. The line will be about 15 miles in length and will involve an expenditure of about $150,000. The company is constructing a hydro-electric plant at Hale's Bar, which will have an ultimate output of 56,000 hp. Anthony Brady, of New York, N. Y., is president of the power company, and John Bogart, of 16 Exchange Place, New York, N. Y., is engineer.

NASHVILLE, TENN.—The Board of Public Works has awarded contracts for the electrical machinery for the municipal electric light plant as follows: To the Allis-Chalmers Company, of Milwaukee, Wis., for turbo-generator set, at $43,490; exciters, etc., $6,740; Nashville Machine Company, for pumps, $3,673; steam-piping, etc., $2,725; steel tank, $267; Westinghouse Electric & Manufacturing Company, for switchboards, etc., $4,865. J. W. Pentecost is superintendent.

BASTROP, TEX.—The city is considering the question of purchasing the local electric light plant and water works systems. F. A. Orgain is city secretary.

HOUSTON, TEX.—The Houston Electric Company contemplates extending the Harrisburg extension of its system down the bay to La Porte, Seabrook and other bay shore points. David Daly is manager.

ALTA, UTAH.—Plans are being made for the construction of power plant on Little Creek, about two miles below Alta, where from 300 to 400 hp will be developed. William Thornton, Harvey Bickerton and Fred Ray are interested in the project. O. H. Skidmore is engineer.

MARYSVALE, UTAH.—The Gold Development Company is planning extensive improvements to its property during the next six months, which will involve an expenditure of about $250,000 and include the construction of a 600-kw electric plant and an aerial tramway down Bullion Canyon, also a 50-ton stamp mill to be built near the property and cyanide mill.

OGDEN, UTAH.—Application has been made to the Board of County Commissioners by the Oregon Rapid Transit Company for a franchise to extend its railways on First Avenue, east of the city limits, for a mile and a quarter.

OGDEN, UTAH.—The Ogden Rapid Transit Company is reported to be considering plans for extending its system to Huntsville, and also plans to build a railway from the Utah Hot Springs north as far as Brigham City. The company also contemplates extending its local system on Grant, Lincoln or Wall Avenues.

SALT LAKE CITY, UTAH.—The Boston Consolidated Mining Company has ordered a large electrically driven pump, capable of raising 3000 gal. per minute to the mill to take the place of two now in operation at its mines.

BALLSTON, VA.—The Washington, Arlington & Falls Church Railway Company is planning to build a new substation in the near future.

BRISTOL, VA.-TENN.—The Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., has been awarded a contract by the Bristol Gas & Electric Company for furnishing additional equipment for its power plant, including two generators rated at 300 kw each, condenser and turbine engine to operate dynamos.

BUENA VISTA, VA.—The Rockbridge Power Company is planning to develop water power on North River and proposes to supply electricity in Buena Vista, Glasgow, Buchanan and, possibly, Lexington, Va. The company has recently secured a franchise to furnish electricity for lamps and motors in Buena Vista. The company proposes to locate substations in each of the cities where it furnishes electrical service.

CHARLOTTESVILLE, VA.—The Charlottesville & Albemarle Railway Company is planning to increase the output of its power house and will install a 150-kw, 550-volt, direct-current generator. R. R. Case is general superintendent.

FORT MONROE, VA.—Bids will be received until Oct. 19 for heating, wiring and electrical fixtures for one double set non-commissioned officers' quarters; plumbing, wiring and mechanical fixtures for two double sets firemen's quarters, at Fort Monroe, Va. Captain Ernest T. Tilton is constructing quartermaster.

LYNCHBURG, VA.—The Lynchburg Traction & Light Company has recently awarded contracts for an addition to its power house. The equipment will include two Babcock & Wilcox 400-hp boilers, heaters, stack, etc., and also a 500-kw General Electric rotary converter. The cost of the work is estimated at about $26,000.

RICHMOND, VA.—Plans and specifications prepared by E. W. Trafford, consulting engineer, for the water pumping portion of the proposed municipal electric light plant have been approved by Charles E. Bolling, city engineer, and other city officials. The plans call for four electric units, each with a capacity of pumping 4,000,000 gal. of water per day. The committee recommends that the plans be adopted by the City Council and that bids be called at once for the erection of pumps, the cost of which is estimated at $17,000. It is proposed ultimately to use the present pumping station for a power house and to erect transmission lines to the new pumping station to furnish electricity to operate the pumps, and also to install a system for lighting the streets of the city. The Board of Aldermen last July passed an ordinance appropriating $350,000 for the project.

BELLINGHAM, WASH.—The Whatcom County Railway & Light Company has applied for a franchise to construct a railway on North Street, from Dock to Yew Streets, a distance of about one mile.

EVERETT, WASH.—It is reported that the Great Northern Railway Company will build two additional power plants, which will be duplicates of the plant now being built at Drury, near Leavenworth.

SUNNYSIDE, WASH.—A franchise has been granted to Robert E. Cavette, of Spokane, Wash., to establish a light, water and cold storage plant.

TACOMA, WASH.—Plans are said to have been completed for a large

power merger in this section. The Puget Sound Electric Company, which supplies power for the Puget Sound Electric Railway and the Tacoma & Seattle street railway systems; the White River Power Company, which is building a large plant on White River, with Lake Tapps as a storage reservoir, and the Seattle-Tacoma Power Company, formerly the Snoqualmie Falls Power Company, are said to have already been taken into the combine. All the Stone & Webster power plants now in operation and a number of new plants to be built in this State will be taken into the organization. The corporation perfecting the power combine is a New York concern.

CORLISS, WIS.—Application has been made to the Council by John Hoyer for a franchise to install and operate an electric light plant and water works system.

CUMBERLAND, WIS.—It is reported that the city has awarded the contract for the construction of the municipal electric light plant and water works system to J. G. Robertson, of St. Paul, Minn., for $17,000. Oscar Claussen, of St. Paul, Minn., is engineer.

KENOSHA, WIS.—The Kenosha Gas & Electric Company has submitted a proposition to the City Council offering to furnish electricity for lighting the streets of the city at the rate of $60 per lamp per year on a moonlight schedule and $69 per lamp on an all-night schedule on a 10-year contract.

MILWAUKEE, WIS.—The City Council is considering plans for lighting the Sixth Street Viaduct, plans for which will be submitted by Commissioner J. P. Sherer of the Board of Public Works and David McKeith, city electrician.

VIROQUA, WIS.—The Viroqua Electric Light Company is planning to rebuild its electric plant and greatly improve the service. The City Council recently granted the company an extension of its franchise, and the plant will be enlarged to meet the demands of the city for years to come.

SHERIDAN, WYO.—Steps have been taken by the Sheridan, Westville & Indianapolis Traction Company for the construction of an electric railway from Sheridan to Carmel by the way of Westville.

VANCOUVER, B. C., CAN.—The British Columbia Electric Street Railroad Company has awarded a contract to the John Macdougall Company, of Montreal, for the installation of a 11,000-hp turbine for its plant at Lake Buntzen, which, with other improvements to be made, will cost about $300,000. R. H. Sperling is general manager.

VANCOUVER, B. C., CAN.—Announcement has been made that the British Columbia Electric Railway Company will make extensions to its system during the present year, dating from July 1, which will involve an expenditure of about $112,000 and will include the following work: Cemetery extension, $35,000; extension to lighting system, $30,000; railway feeders, $15,000; new buildings, $12,000; relaying tracks, $10,000, and Gorge Park, $10,000.

WINNIPEG, MAN., CAN.—The Winnipeg Electric Street Railroad Company has submitted a proposition to the City Council offering to enter into a contract to supply the city with 10,000 electric horse-power for 10 years at the ratio of $18.40 per horse-power per year, and will guarantee the supply. The matter will be taken up by the City Council at its next meeting. Wilford Phillips is superintendent of the company and H. N. Ruttan, city engineer.

ST. JOHN'S, N. F.—The local electric plant has been closed down owing to lack of water. The streets are in darkness and the street cars out of service.

YARMOUTH, N. S., CAN.—The Yarmouth Street Railway Company contemplates building an addition to its power house in which to place its high-tension apparatus.

WINDSOR, N. S., CAN.—The Windsor Launch & Power Company is considering the question of building a plant in Windsor.

BELLEVILLE, ONT.—Notice has been given that application will be made to the Legislature for permission to build an electric railway from Belleville to Port Ann, a distance of about five miles.

CHATHAM, ONT., CAN.—Arrangements have been made between the Chatham Gas Company and the Lake Erie Electric Railway whereby the former company will supply electricity for operating the entire railway system from Wallaceburg to Lake Erie. The Chatham Gas Company will install additional equipment and machinery in its plant to increase the output of the plant to meet the requirements of this contract, work on which will begin at once.

DUNNVILLE, ONT., CAN.—The Dunnville, Wellandport & Beamsville Electric Railway Company will soon award contracts for the construction of its proposed electric railway, which will connect Dunnville, Wellandport and Beamsville, across the Niagara peninsula from Lake Erie to Lake Ontario. James A. Ross, of Wellandport, Ont., is president, and R. T. Gough, of Toronto, Ont., chief engineer.

NORTH BAY, ONT., CAN.—The North Bay Light, Heat & Power Company has submitted a proposition to the City Council asking for a 20-year franchise, three years of which is to be exclusive, and offers to furnish electricity generated by steam power at 15 cents per kw-hour with a discount of 20 per cent; if it should be able to operate by water power, it will supply electrical energy at 15 cents per kw-hour with a discount of 20 per cent, and a further discount of 10 per cent if paid within 20 days, and a still further discount of 5 per cent if paid within 10 days. If this proposition does not meet the approval of the Council, the company offers to sell the plant, including the gas plant, to the city for $75,000.

PORTSMOUTH, ONT., CAN.—The civic authorities of Kingston, Ont., are considering the question of supplying this village with electricity for lamps and motors.

STRATFORD, ONT., CAN.—Plans are being made for the construction of an electric railway from Stratford to Exeter, Hensall, St. Joseph and the shore of Lake Huron. J. Lewis Thimas, of London, Ont., is engineer for the company.

WELLAND, ONT.—The Ontario Power Company is erecting an entirely new transmission line to Welland. Three cables have been strung and three more are to be added.

CHIHUAHUA, MEX.—The Rio Plata Mining Company is considering plans for improvements to its Santa Barbara mining property, which include the construction of a cyanide mill and a hydro-electric plant. It is proposed to operate the mine and cyanide plant by electrical power. A new steam engine will be installed which, with the present steam plant, will furnish power to generate electricity during the low water periods.

TORREON, MEX.—Plans are being made for the construction of a large dam across the Nazas River at a point where it emerges from the mountains, in the San Fernandez Canyon, about 100 miles southwest of Torreon. The cost of the dam is estimated at $6,000,000, and it is said that the Federal Government has agreed to give its financial support. It is proposed to install a hydro-electric plant, which will furnish sufficient electricity to supply all of the towns within a radius of 150 miles.

New Industrial Companies.

THE IDEAL INSULATOR MANUFACTURING COMPANY OF AMERICA, of St. Louis, Mo., as been incorporated, with a capital stock of $50,000, by Alonzo W. Leayback and H. Coroll Alfred.

THE TELEPHONE SPECIALTY COMPANY, of Wilmington, Del., has been incorporated, with a capital stock of $300,000, by Ralph C. Lupton, George C. Maris and George B. Lewis, of Wilmington, Del.

AMERICAN ANNUNCIPHONE COMPANY, of Portland, Me., has filed articles of incorporation, with a capital stock of $500,000, for the purpose of manufacturing and selling telephone, telegraph and electrical machinery.

THE AGAWAM WATERPROOFING & CONDUIT COMPANY, of New York, N. Y., has been incorporated, with a capital stock of $100,000, by Harry M. Spruce, of Brooklyn, Edward McInnes and Monroe M. Schwarzschird, of New York, N. Y.

THE OSWALD ELECTRIC & ENGINEERING COMPANY, of New York, N. Y., has been chartered, with a capital stock of $1,000, and the following-named directors: Oscar G. Pouch, William Heybrock and Frank Henderson, all of New York, N. Y.

THE SUNRAY ELECTRIC LAMP MANUFACTURING COMPANY, of New York, N. Y., has been incorporated, with a capital stock of $30,000, for the purpose of manufacturing lamps. Dr. S. Nordlinger, of New York, N. Y., is interested in the enterprise.

THE THOMAS B. WHITTED COMPANY, of Charlotte, N. C., has been incorporated, with a capital stock of $100,000, to carry on a general machinery supply business, including electrical appliances. The incorporators are: J. R. Purser and F. I. Osborne and others.

THE INTERNATIONAL TELEPHONE COMPANY, of Chicago, Ill., has been incorporated, with a capital stock of $60,000, by F. M. Burmeister, H. Shafer and J. C. Burmeister, of Chicago, Ill. The company proposes to manufacture telephone and telegraph devices.

THE SCHIMEL GAS & ELECTRIC FIXTURE COMPANY, of New York, N. Y., has been incorporated, with a capital stock of $3,000 and the following-named directors: Morris Friedman, Benjamin Goldstein, of New York, N. Y., and Samuel Maltz, of Brooklyn, N. Y.

THE TURBINE EQUIPMENT COMPANY, of Trenton, N. J., has been incorporated, with a capital stock of $50,000, by Harry Y. Hayden, Russell Klemm and Barker G. Hamill. The company proposes to do electrical, civil and hydraulic engineering and contracting work.

JAMES LECKIE & SONS COMPANY, of Camden, N. J., has been incorporated to manufacture gas and gasoline engines, automobiles, machinery, etc. The capital stock of the company is placed at $250,000. and the incorporators are F. R. Hansell, J. A. MacPeak and G. H. B. Martin, all of Camden, N. J.

THE SAFETY ELECTRIC RAILWAY COMPANY, of Dover, Del., has been incorporated, with a capital stock of $50,000, to operate miniature electric railways at amusement resorts. The incorporators are: Andrew H. Angle, Abraham Garbiel, of Philadelphia, Pa., and William I. N. Lofland, of Dover, Del.

New Incorporations.

HUNTSVILLE, ALA.—The Huntsville, Chattanooga & Birmingham Interurban Railway, Light & Power Company has been incorporated, with a capital stock of $50,000, for the purpose of constructing an electric railway from Huntsville, with branches to Chattanooga and Birmingham. The officers of the company are: Mrs. J. V. Lowry, president; William J. Pulley, of New York, N. Y., vice-president; N. O. Wallace, of Fayetteville, secretary; Charles H. Pulley, of Huntsville, treasurer, and E. L. Pulley, general manager.

FORT SMITH, ARK.—The Fort Smith-Oklahoma Light & Traction Company has been incorporated, with a capital stock of $30,000. The incorporators are: P. K. Reiss, president; I. S. Lowrey, vice-president; E. H. Thomas, secretary, and Rudolph Ney, treasurer.

ATLANTA, GA.—The Sparks Western Railway Company has applied for a charter to construct a railway, 25 miles in length, from Sparks to Moultrie. The company is capitalized at $100,000 and the incorporators are John R. Barfield, R. L. Wilson, W. J. Rogers, H. C. McDaniel, B. Z. Whitehurst and others.

ELDORADO, ILL.—Articles of incorporation have been filed for the Saline County Traction Company to build an electric railway from Eldorado through Larrisburg to Carriers Mills. The railway will be about 17 miles in length, and the principal office will be located in Danville, Ill. The company is capitalized at $5,000, and the incorporators are: L. E. Fischer, of Danville, Ill.; J. A. Swanberg and A. C. Murray, of Springfield, Ill.; W. L. Murphy and L. W. Johnson, of Danville, Ill.

NEW YORK, N. Y.—Articles of incorporation have been filed for the Greater New York Traction Company by C. F. Thum, Arthur G. Still, Joseph W. Spencer, Frank S. Burns, Charles M. Koop, John A. Gallagher, A. C. Austin, Jr., E. M. Fuller and R. W. Alexander. The company is capitalized at $15,000 and proposes to operate a street railway about one mile in length by electricity in Fulton, Cortlandt and William Streets and Maiden Lane, thereby affording a crosstown service connecting with the Brooklyn Bridge and the Fulton, Cortlandt and Barclay Street ferries. The company will apply to the Public Service Commission for franchises in several streets now occupied by horse car lines. It is proposed to charge a three-cent fare.

Personal.

MR. JAS. C. WOODCOME, formerly superintendent of the Houghton County (Mich.) Electric Light Company, is now superintendent of the Dallas (Tex.) Electric Light & Power Company.

MR. LOUIS FRITCH, assistant to President Hanrahan, of the Illinois Central Railroad, is in New York City inspecting the operating conditions of the New York Central electrical transportation system.

MR. C. E. F. AHLM has been appointed by the city of Lima, Ohio, consulting engineer of the municipal lighting plant, for which $80,000 have been appropriated. The plant will consist of one 200-kw and one 300-kw 2300-volt, 60-cycle, three-phase alternators direct connected to compound engines.

DR. N. MONROE HOPKINS has resigned his position of electrical engineer to the United States Navy Department and has resumed his connection with the firm of Munroe, Hall & Hopkins, chemists and consulting engineers, Bond Building, Washington. He will also prosecute various inventions on which he is engaged.

MR. VINCENT GRAY has been engaged by the Westinghouse Electric & Manufacturing Company to take charge of detail and supply service and lamp sales in Milwaukee and adjacent territory. Mr. Gray has been connected with the Columbia Incandescent Lamp Company, of St. Louis, for several years past, during which time he has had charge of territory in Illinois for that company.

DR. EDWARD P. HYDE, now of the Bureau of Standards, after Oct. 1, 1908, will organize and direct a department of physical research under the auspices of and at the expense of the National Electric Lamp Association. Dr. Hyde and his staff will, it is announced by the association, operate the new department with entire freedom from commercial suggestion and with the same frank publicity which has characterized his work at the Bureau of Standards.

MR. H. H. CUDMORE has been engaged by the Brilliant Electric Company, of Cleveland, as general sales manager. He has been identified for the past 12 years with electrical interests in and near Cleveland. As the product of the Brilliant Electric Company is marketed very largely through jobbers, his knowledge and experience in the supply business will enable him to serve such customers to the best advantage. Mr. Cudmore assumed his new duties on Sept. 1, since which date he has been on an extended trip through the East, making the acquaintance of his trade and studying business conditions.

MR. C. L. DE MURALT has been reappointed Professor of Electrical Engineering at the University of Michigan for the coming year. During the winter semester Prof. De Muralt will devote his attention to the consideration of the more general aspects of applied electricity. The course of lectures will include the discussion of: (1) The characteristics and application of alternating and continuous current motors. (2) The design, construction and operation of electric plants. (3) The principles and methods of transmitting, distributing and controlling alternating currents. (4) The calculation and operation of electric railways. (5) The management of electric properties, with special references to the commercial aspects of electrical engineering.

Obituary.

MR. ALBERT P. SEYMOUR, for many years active in Pass & Seymour, Inc., manufacturers of electrical specialties at Solvay, N. Y., died Sept. 13 at his residence at Monrovia, Cal. On account of failing health in 1906, Mr. Seymour retired from the business, disposing largely of his interests, and has since resided in Monrovia. A year ago he came to Syracuse on a visit, and in October was taken ill there and confined to his bed until July of this year, when he returned to California. Mr. Seymour was actively engaged in business in Syracuse, N. Y., for many years. He was connected as an electrician some years with the Electric Light & Power Company, now the Syracuse Lighting Company. Later he became a member of the firm of Pass & Seymour, which became Pass & Seymour, Inc. Besides a widow, he is survived by a son, Mr. Albert P. Seymour, Jr., of Monrovia.

Legal.

POWER COMPANY'S CLAIMS AGAINST STATE.—The Niagara, Lockport & Ontario Power Company has filed a claim against the State of New York for $103,000 for lands and rights taken by the State for the barge canal in Baldwinsville, Onondaga County. The company asks for $75,000 for lands and apparatus and $28,000 for a branch transmission line appropriated.

SOUTH CAROLINA ELECTRIC PLANTS IN RECEIVERS' HANDS.—Judge J. C. Pritchard, of the Federal Court, for the Western District of North Carolina, has granted petitions for a receiver for electric plants at four South Carolina towns—Rock Hill, Darlington, Florence and Marion. The first petition was for a receiver for the Rock Hill Water, Light & Power Company, following a suit against the company brought by the Commonwealth Title Insurance & Trust Company, and P. A. Wilcox, of Florence, S. C., was named receiver. The petition for a receiver alleged mismanagement and failure to pay interest on bonds. The receiver was empowered to issue $50,000 in receiver's certificates. Mr. Wilcox was also appointed receiver of the Carolina Water, Light & Power Company, with plants in Marion and Darlington, and of the Florence Light & Power Company, of Florence, S. C. In the case of the Carolina Company the receiver is empowered to issue $30,000 in receiver's certificates, and in the case of the Florence Company, $20,000 in certificates. The above companies were operated by the Southern Public Service Corporation.

Trade Publications.

THE F. BISSELL COMPANY, of Toledo, O., has issued a small calendar for September, with a bit of sole leather attached, the calendar being for the "sole" reason and purpose of getting some orders in for electrical supplies and apparatus.

INSULATED WIRE.—"Rubber Covered Wires of Quality" is the title of Price List No. 22, just issued by the New York Insulated Wire Company, giving prices on rubber-covered wires on the various copper bases, from 11 cents to 21 cents, and including various tables which will be found of service.

DEAN POWER PUMPS.—Dean Bros.' Steam Pump Works, Indianapolis, Ind., has issued Catalogue No. 71, devoted to its standard pumping machinery. Details and illustrations are given of a large variety of the apparatus, inclusive of motor-driven pumps. One portion of the catalogue deals with air compressors.

Business Notes.

INSULATING PAINT.—The Metropolitan Electrical Supply Company, Chicago, Ill., is introducing a new insulating paint, made by Frank S. DeRonde Company, of New York, who was long connected with the Standard Paint Company. It is also sending out a metal polish, made by the same company. Both articles are claimed to have superior merit.

THE U. T. HUNGERFORD BRASS & COPPER COMPANY, 497 Pearl Street, New York, is especially inviting the attention of manufacturers of electroliers to its "star brand" brazed brass tubing. To successfully meet the requirements of the trade brazed brass tubing must possess certain characteristics which this company with its up-to-date machinery has been able to secure in its "star brand." The metal to produce the best quality of brazed tube must be dense and homogeneous, and the brazed seam strong and absolutely sound. By using metal that contains a high percentage of copper it is possible to employ an extremely hard brazing solder for making the joints. The tubes when properly annealed, may be bent into a variety of shapes without splitting. Particular attention is also devoted to the finish of the tubes so that they can be polished with the minimum amount of labor. Large stocks of all sizes are carried by the firm, enabling it to fill orders promptly.

MATTHEWS' SPECIALTIES.—W. N. Matthews & Brother, St. Louis, have dropped the old names of all of their specialties and substituted therefor the word "Matthews." In a circular on the subject it is stated that careful investigation has shown that the name of W. N. Matthews & Brother is better known than those of a large number of other inventors of Matthews' specialties, each of which have been advertised extensively under its name, but in each case over the firm name. The latter name has thus been advertised 10 times for every one of any one of the 10 specialties that the firm manufacture. It has seemed that it will be an aid to all interested to identify the specialties henceforth by giving them the firm name. The name "Matthews'" before any specialty will be a guarantee of its value, as the firm could not afford to put it there unless the goods were entirely worthy.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED SEPT. 15, 1908.

[Conducted by Rosenbaum & Stockbridge, Pat. Attys., 41 Park Row, N. Y.]

898,473. RAILWAY SIGNAL; John Hoffer, Louisville, Ky. App. filed Jan. 14, 1908. A signal system for use at the curves of a railway and including mechanically operated tappets depressed by the wheel flanges and mutually connected together to set appropriate signals at each side of the turn. Includes a form of semaphore signal which is operated by an electromagnet.

898,485. DEVICE TO PREVENT TROLLEY WHEELS FROM JUMPING; William O. Lane, Cleveland, O. App. filed Dec. 20, 1907. Trolley harp has a rigid yoke fixed thereto, the arms of which embrace the trolley conductor. A pair of longitudinal guides are attached to the yoke to avoid any rigid corners which might become entangled in the guy wires.

898,506. APPARATUS FOR THE PRODUCTION OF OZONE; John R. Quain, London, England. App. filed Feb. 12, 1907. Includes a generator having positive electrodes, each in a vacuum tube and a plurality of negative electrodes also in vacuum tubes, and a means for passing air between said tubes.

898,509. ELECTRICAL CIRCUIT PROTECTOR; Charles A. Rolfe, Adrian, Mich. App. filed Feb. 13, 1908. The thermal element is supported between a pair of spring blades, which are normally held against separation thereby. The thermal element includes a pair of spring tongues, which are held in a predetermined forked relation by solder so as to maintain the thermal element in its holding relation to the spring blades.

898,529. ELECTRICAL LABORATORY APPARATUS; Chester H. Thordarson, Chicago, Ill. App. filed April 17, 1908. A laboratory device for showing induction phenomena and including magnet cores and separable coils, which can be quickly built up to form a transformer.

898,540. ELECTRICAL FITTING; Edson B. Wilcox, Meriden, Conn. App. filed May 29, 1908. A rosette connection designed to avoid the usual knot which is tied in the extension cord to resist the strain thereon. The conductors are looped through tortuous passages in the rosette, which resist the strain.

898,544. TELEPHONE TRANSMITTER; Henry F. Albright, Elizabeth, N. J. App. filed Oct. 28, 1907. In a telephone transmitter, a button provided with a movable electrode, having a stem projecting therefrom, a diaphragm, means for supporting said button and diaphragm, a bushing on said diaphragm, having a tapered opening through which said stem projects, and means for clamping said bushing about said stem.

898,576. TELEPHONE SWITCH; Verne E. Green, Galva, Ill. App. filed Oct. 6, 1907. The combination of a pair of contact plates, pairs of switch blades having one blade of the respective pairs in electrical connection with one of said plates and electrically insulated from the other plate, and having the other switch blade electrically insulated from the first-mentioned plate and electrically connected with the other plate, and a second pair of contact plates arranged to electrically connect parts of switch blades when moved out of contact with the first-mentioned pair of plates.

898,578. ELECTRIC HEATER; Andrew J. Holmes, Tacoma, Wash. App. filed May 10, 1906. An electric heater for use wholly with alternating currents. The resistance element includes a coil and core, both of hard steel, having a large hysteresis effect.

898,607. ILLUMINATING APPARATUS; Jean Schmidt, Frankfort-on-the-Main, Germany. App. filed May 8, 1907. Has a plurality of pairs of electrodes suspended within a casing and arranged in different parallel planes, and means for simultaneously adjusting an electrode of each pair to regulate all of the arcs.

898,619. TELEPHONE APPARATUS; Frank W. Wood, Newport News, Va. App. filed April 17, 1907. A telephonic apparatus comprising a concentrically arranged mouthpiece and trumpet, the one projecting through the wall of the other.

898,620. TELEPHONIC APPARATUS; Frank W. Wood, Newport News, Va. Ap. filed April 5, 1907. In a telephonic apparatus, a casing, a partition therein, a receiver on one side of said partition, a transmitter on the other side of said partition, and a hollow receiver arm journaled in said partition.

898,643. INDICATOR; Walter O. Haymond and John O. Potter, Muncie, Ind. App. filed May 29, 1907. The pointer or index of a steam or other gage is adapted to engage contacts which are angularly adjustable on the rim of the device. The contacts have handles projecting through circumferential grooves, by which they are adjusted.

898,649. ELECTRIC CLOCK; Monnosuke Higuchi, New York, N. Y. App. filed March 17, 1908. Electric clock, in which an electric impulse is only received when the impulse of the balance wheel weakens. Provides an actuating mechanism to permit the hour and the minute hands of the clock being turned forward or backward independently of the actuating mechanism.

898,686. ELECTRIC BELL; Tito Rosati, Florence, Italy. App. filed Aug. 7, 1907. Electric bells operatable with high potential circuits. The bell includes resistance coils of manganina, which are made the operating magnets of the bell.

898,691. ELECTRIC FURNACE PROCESS; George O. Seward and Franz von Kugelgen, Holcombs Rock, Va. App. filed Feb. 21, 1906. The process of operating an electric furnace, which consists in maintaining a deep layer of the charge into which the electrode projects and by which it is surrounded, so that the arc is buried beneath the charge, and effecting renewal of the electrode material by progressive feeding in of new lengths without withdrawal of the electrode from the charge.

898,698. FUSE-BOX; John O. Stivers, Denver, Colo. App. filed Oct. 26, 1908. A supply of fuse cartridges are provided on a hexagonal wheel which is revolved to put a new fuse cartridge in circuit whenever desired.

898,699. PORTABLE TELEPHONE APPARATUS; Frederick F. Strong, Boston, Mass. App. filed April 3, 1905. A telephone transmitter-receiver, having a sound collector provided with a centrally apertured sound receiving device leading to the ear mounted within the mouthpiece thereof.

898,715. INCANDESCENT LAMP; Frederick M. Bennett, New York, N. Y. App. filed March 6, 1908. A form of filament for a glow-lamp adapted to secure an equal and advantageous distribution of light. The filament is looped in horizontal and vertical planes.

898,751. CONDUIT COUPLING; Hubert Krantz, New York, N. Y. App. filed Oct. 18, 1907. A sheet metal conduit coupling which is bent into shape without any metal drawing processes. The metal is initially stamped with slots to permit its being bent into the required form.

898,752. METAL FILAMENT FOR ELECTRIC INCANDESCENT LAMPS; Hans Kuzel, Baden, near Vienna, Austria-Hungary. Filed July 16, 1907. Support for tantalum or tungsten filament in an incandescent lamp.

898,756. OUTLET BOX; George A. Lutz, New York, N. Y. App. filed Jan. 5, 1907. An outlet box or connector for conduit pipes made of cast metal, with a removable cover plate. The cover plate is designed to receive outlet bushings and has overhanging edges to shed water from the box.

898,766. ELECTRIC SWITCH AND SYSTEM OF CONTROL; Joseph V. Mott, New York, N. Y. App. filed Feb. 2, 1907. A switch mechanism comprising a plurality of pivotally mounted connecting switches adapted to tilt in either direction and each provided internally with a mobile conductor and a plurality of terminals at each side.

898,771. COMBINATION ELECTRIC SERVICE CUT-OUT AND METER-PANEL; Henry E. McGowan and Edwin R. Ellsworth, New York, N. Y. App. filed March 9, 1907. A means for enclosing and protecting the electrical connections of meters and the like. Designed to prevent tampering therewith or danger from mechanical injury, and lessening the liability to fires. Includes a complete cast metal housing of special design.

898,782. ELECTRIC HOIST; Gustav Rasmus, New York, N. Y. App. filed Jan. 28, 1908. The motor and hoist equipment depends from a carriage traveling on the lower flange of an I-beam which constitutes a telpher rail.

898,785. ELECTROLYTIC APPARATUS; Marcus Ruthenburg, Lockport, N. Y. App. filed Jan. 18, 1907. Has an electrode comprising a cylinder composed of volute layers of wire cloth and means for maintaining said layers in spaced relation, comprising spacing washers and connecting bolts. Designed to decompose sodium chloride and form sodium hydrate.

898,796. TELEPHONE SET; Sol S. Sonneborn, New York, N. Y. App. filed Oct. 1, 1907. In a desk telephone, a hollow standard or column having a transmitter and a switch hook, a telephone receiver forming part of said standard; a pair of ear cups or pieces, and tubular connections therefrom to said receiver.

898,822. PLURAL LAMP SOCKET; Reuben B. Benjamin, Chicago, Ill. App. filed Feb. 23, 1907. Cluster lamp socket having a porcelain base with center contacts and ring shaped clips depending therefrom, which support the threaded shells. The clips are connected together beneath the shells.

898,823. PLURAL LAMP SOCKET; Reuben B. Benjamin, Chicago, Ill. App. filed Feb. 27, 1907. Relates to modifications of the above.

898,824. PLURAL LAMP SOCKET; Reuben B. Benjamin, Chicago, Ill. App. filed Feb. 28, 1907. Covers additional modifications.

898,825. PLURAL LAMP SOCKET; Reuben B. Benjamin, Chicago, Ill. App. filed March 1, 1907. Covers still further modifications.

898,826. PLURAL LAMP SOCKET; Reuben B. Benjamin, Chicago, Ill. App. filed March 1, 1907. A cluster socket including a hemispherical cup perforated to receive the threaded shells, and a common center contact formed of a sheet metal stamping, all supported by a porcelain base.

898,858. MEANS OF OBVIATING THE DELETERIOUS EFFECTS OF OSCILLATIONS; Clarence Feldmann, Delft, Netherlands, and Josef Herzog, Budapest, Austria-Hungary. App. filed Jan. 30, 1907. In order to avoid the injurious effects of oscillations occurring in iron sheathed cable systems, patentee has the fittings constructed with their upper parts of non-magnetic metal, such as bronze, which reduces the inductance for the purpose stated.

898,888. SPARK GAP; Isaac S. Hirsch, New York, N. Y. App. filed July 18, 1907. A spark gap for X-ray machines, designed to be included between each connection of the secondary winding of the induction coil and the vacuum tube. The spark gap has one member, consisting of a revoluble frame and non-rotatable conducting disks secured thereto.

898,898. TELEPHONE RECEIVER SUPPORT; Mose M. Kahn, Louisville, Ky. App. filed Aug. 30, 1907. A telephone receiver support, comprising a bracket having one end provided with means for connecting it with the transmitter support and having the other end provided with means for supporting the receiver, said bracket having its intermediate portion doubled upon itself to form a handle or foot.

898,915. ELECTRIC SIGNALING OR TELEGRAPH APPARATUS FOR USE ON VEHICLES. App. filed June 4, 1907. An indicator system for use on automobiles by which directions may be given to the driver from the tonneau. Has a plurality of glow lamps, which exhibit appropriate inscriptions when selectively illuminated.

898,979. PROCESS OF ELECTRICALLY CONNECTING FILAMENTS TO SUPPLY WIRES IN ELECTRIC GLOW LAMPS; Hans Kuzel, Baden, near Vienna, Austria-Hungary. App. filed March 26, 1907. The process of electrically connecting filaments to supply wires in electric glow lamps, which consists in mixing finely powdered metals melting and forming carbides at high temperatures with carbonaceous substances and with an agglomerant whereby a plastic mass is obtained, applying such plastic mass to the points to be connected and gradually heating such mass in the absence of air to a white heat, whereby carbides of the said metals are formed and fused and finally permitting the same to cool.

898,987. RHEOSTAT; Heinrich Poth, Brooklyn, N. Y. App. filed Dec. 8, 1905. Cylindrical tank contains mercury, which is made to short circuit a greater or less length of a spirally wound resistance element.

898,992. ALARM; Jay A. Robinson, Denver, Colo. App. filed Oct. 26, 1907. Has an electromagnet in an electric circuit, so located that when circuit is closed the magnet acts to hold the hook of a telephone receiver in depressed position.

899,012. ELECTRIC CLOCK; Monnosuke Higuchi, New York, N. Y. App. filed Sept. 15, 1905. An electric clock of a type actuated by an electric impulse and designed so that the electric impulse is only received when the impulse of the balance wheel weakens. Has hour and minute strike mechanisms in which the hour and minute strikes are contra-distinguished, and means whereby such strikes may be repeated at will.